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THE GORDON REVIEW

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IN THIS ISSUE . . .

In carrying out an emphasis on science as we approach the one hundredth anniversary of Darwin's *Origin of the Species*, the editors asked a number of men who have distinguished themselves in special fields of science to prepare articles for publication in this and subsequent issues of the *Review*. The majority of the present group belong to the school of thought that would accept a type of theistic evolution as compatible with the Christian position. Future papers will deal with opposing viewpoints. The end in view is well stated in Professor Leith's introduction — that the *Review* may function as a forum of Christian opinion.

Walter R. Hearn, who deals with the current attempt of man to create life, is Assistant Professor of Chemistry at Iowa State College, where he teaches biochemistry and is engaged in research, particularly in the field of peptide chemistry. He received his B.A. from Rice Institute, the Ph.D. from the University of Illinois, and was subsequently on the biochemistry faculties of Yale University School of Medicine and Baylor University College of Medicine. A number of his scientific papers and popular articles have been published. He is a member of Phi Beta Kappa, Sigma Chi, Phi Lambda Upsilon, and Phi Sigma, as well as the American Chemical Society, the A.A.A.S., and the Society for the Scientific Study of Religion.

Henry W. Seaford, Jr., has appeared in the pages of the *Review* before ("Anthropology in the Christian Weltanschauung," May, 1957). His present article faces the evidence for what would have been called in years past the "missing link" and endeavors to suggest the way in which a Christian should respond. Formerly of the Biomechanics Laboratory, Tufts University and engaged in anthropometric research for the U.S. Air Force, he is completing his doctorate in anthropology at Harvard.

A solution to the difficulties of science and religion which will undoubtedly stir *Review* readers to response, is offered by Assistant Professor **Heinrich D. Holland** of Princeton University. Educated in Germany and the U.S., Dr. Holland received his B.A. from Princeton in Chemistry. After a period in which he was engaged in rocket reasearch for the U.S. Army, he took his M.S. and Ph.D. in Geology and Chemistry at Columbia University. He is the author of a large number of articles in various journals of science and is presently writing a text in mineralogy. A recent paper at the Geological Society of America was entitled, "Mineralogic Evidence Bearing on the Evolution of the Earth's Atmosphere."

The philosopher, **Gordon H. Clark**, completes our article presentations by pointing to the neglected implications of an adequate philosophy of science. Dr. Clark is Head of the Philosophy Department at Butler University and has been a frequent contributor to the *Review*.

INTRODUCTORY NOTE

In the conclusion to his epochal *Origin of Species* one hundred years ago, Charles Darwin stated, "I see no good reason why the views given in this volume should shock the religious feelings of anyone." Either his own blindness or the blindness of others proved him a poor prognosticator, for Darwin himself *was* shaken and the Christian church *has* reverberated frequently with cries of shocked indignation for fully a century. So severe has been the reaction that even today some consider Biblical Christianity and biological evolution as mutually exclusive world-views . . . and this applies to followers of either perspective! It is rather trite therefore to say that areas of apparent conflict do remain but it would be invalid to assume thereby that the last word has been spoken as to their finality.

In its desired tradition of acting as a forum for the best in Conservative Christian study and of stirring enlightening thought in its readers, the *Review* in this and several subsequent issues will offer on this centenary a number of papers expressing the attitudes toward at least some facets of evolution of a number of competent young Christian scientists. These daily face the problem of relating their faith to the facts and theories of their disciplines, hence have undoubtedly thought long and prayerfully about their resulting syntheses. A conscious attempt has been made to secure provocative analyses, partly to stimulate others to constructive criticism and partly to provide an outlet for views not commonly given expression in some areas of the modern church. If there is to be a stirring of the scientific waters in modern theological Conservatism, it is on the basis of such as these that it will occur.

No scientific theory should be held through time in a rigidly doctrinaire attitude — nor should any competing criticism. The attitude of a Christian toward the facts of biological and geological experience should be open-minded and fair within the confines set by his faith. It is thence imperative to determine the breadth of these confines as well as to be abreast of modern data. Let us hope that these articles will contribute something to such demands. Darwin himself, in his *Descent of Man,* commented, "False facts are highly injurious to the progress of science, for they endure long; but false views, if supported by some evidence, do little harm, for everyone takes a salutary pleasure in proving their falseness; and when this is done, one path toward error is closed and the road to truth is often at the same time opened."

—*Thomas H. Leith*

THE CREATION OF LIFE

WALTER R. HEARN

Every popular magazine seems eventually to feature an article on "How Life Began." New technical books on subjects ranging from protein chemistry to astronomy are finding room for a chapter on "The Origin of Life." Scientific journals announce symposia and conferences on the topic, and the general public seems to be eagerly awaiting the news that some scientist or research team has actually created a living organism. How do evangelical Christians react to all this? Here is a typical response:

> One wonders if there is any limit to the pride and audacity of man, who would, if he could, take God's place as Creator. Only God can give life, and in His Word He tells us plainly and simply how He did it. The wise man believes God in the first place; the fool wastes his whole life in study and toil trying to prove God, only to find in the end that God's Word was right after all. But back behind all this we see the hand of Satan, the god of this world. He is the old imitator, who would imitate all that is of God — and what would he give if he could also create life!

To a Christian biochemist who has a serious interest in the nature of life and whatever can be learned about its origin, it is somewhat disconcerting to find such an interest clearly labeled as diabolical! Indeed, theologians seem able to take more calmly man's interest in life on other planets[1] than his interest in the origin of life on our own planet. Some go so far as to state categorically that life can never be made in the laboratory.[2] Considering the outcome of the clash of many such dogmatic theological assertions with the progress of science in the past,[3] it hardly seems wise for Christians to commit themselves to such a position at the present time.

Clearly, one of the main issues at stake is our attitude toward evolution, defined here as the gradual development of morphologically complex living organisms from simpler forms over long periods of geological time. A common criticism of evolutionary theory in the past has been that it has nothing to say about origins and is therefore an incomplete theory.[4] One hundred years ago, Darwin was content to say in his *Origin of Species,* "Science as yet throws no light on the far higher problem of the essence or

1. See "Theologians and the Moon," *Christianity Today,* vol. 3, no. 1, pp. 25-31 (Oct. 13, 1958). A university biology professor recently gave a good illustration of changing trends in attitudes toward scientific feasibility: To his students' perennial question, "How long will it take man to create life in a test-tube?" he has always replied, "About as long as it will take him to reach the moon." In past years their attitude has been a disappointed, "That long?" This year, however, their excited reply was, "That soon?"
2. R. Laird Harris, "Theological Aspects of Mechanists' Views of the Origin of Life," *Journal of the American Scientific Affiliation,* vol. 10, no. 1, pp. 5-8 (March, 1958).
3. For many well-documented examples, see Andrew D. White, *A History of the Warfare of Science with Theology in Christendom,* New York: D. Appleton & Co., 1896. Republished, New York: George Braziller, 1955.
4. R. E. D. Clark, *Darwin, Before and After,* London: The Paternoster Press, 1950, pp. 126-127.

origin of life,"[5] but it is evident from his other writings that he had given the problem of the origin of life serious consideration.[6] The current scientific view of the process by which life arose on the earth is really an extension of Darwin's idea of natural selection into the pre-biological realm. Obviously, any demonstration of the validity of this mechanism would tend to negate this criticism of evolution and would in fact greatly strengthen the scientific basis for evolution. Furthermore, it may turn out that attempts to study the origin of life may provide more insight into actual biochemical mechanisms of evolution than have studies of the chemical processes going on in already living things. It is no wonder that Christians who feel that evolution is incompatible with the revealed Word of God are uneasy over these recent developments.

When we recall that *The Origin of Species* was first published in 1859, it seems quite remarkable that Darwin cautiously avoided any speculation about the origin of life. For it was not until 1862 that Pasteur's critical experiments disproving spontaneous generation were published, and even after that a number of investigators such as Bastian continued to claim that living microorganisms could arise spontaneously from inanimate matter under appropriate conditions. Of course, eventually, the work of Pasteur and Tyndall carried the day, but in 1859 Darwin could easily have called on scientific evidence as well as the long tradition of belief in spontaneous generation to extend his theory further back into the remotest geological ages.

The controversy over spontaneous generation is one of the most fascinating stories in the history of science.[7] Belief in spontaneous generation had arisen from naive observations in ancient times and had been endorsed by the testimony of learned scholars from Aristotle to Descartes. The conclusiveness with which the age-old concept was finally demolished is a tribute to the experimental ingenuity and thoroughness of the victors, and to the fairness with which they were willing to deal with their opponents.[8] The outcome of this controversy established the doctrine that microorganisms arise only from living microorganisms or their spores. The

5. Charles Darwin, *The Origin of Species by Means of Natural Selection,* with additions and corrections from the 6th and last English edition, New York: D. Appleton & Co., 1920, p. 294.
6. Francis Darwin, Ed., *The Life and Letters of Charles Darwin,* New York: D. Appleton & Co., 1896, Vol. II, pp. 202-203 and pp. 346-348.
7. For a detailed account, see William Bulloch, *The History of Bacteriology,* London: Oxford University Press, 1938, Chapter IV, "Spontaneous Generation and Heterogenesis." For a shorter account, see Charles Singer, *The Story of Living Things,* New York: Harper & Bros., 1931, Chapter XII, "Biogenesis and its Implications."
8. J. B. Conant, Ed., "Pasteur's and Tyndall's Study of Spontaneous Generation," *No.* 7 in *Harvard Case Histories in Experimental Science,* Cambridge, Mass.: Harvard University Press, 1953; Published in 2 Vols., 1957, Vol. II, pp. 489-539, contains translations of excerpts from papers by Francesco Redi (1668) and Pasteur (1862) and excerpts from Tyndall's papers of 1876-1878.

preparation of pure cultures and the science of bacteriology were thus made possible. The practical results of this doctrine in medicine and public health are shared by all people and have added tremendous weight to the conclusions of Pasteur throughout the past century. Why, then, are we witnessing this recent surge of interest in the possible origin of life from inanimate matter? Has there been new evidence to cast doubt on the doctrine upon which all microbiology is based?

The answer to this last question is, No. Pasteur's conclusions about spontaneous generation are still valid — but the nature of those conclusions must be understood. Pasteur did not claim to have proved that life could never under any circumstances be generated from non-living matter; he clearly realized that such could not be proved, being a proposition in the form of a universal negative. His experiments did establish that no claim for spontaneous generation should be accepted until all possibility of contamination by previously living microorganisms had been ruled out. And indeed, whenever sufficient care has been taken to exclude contamination, no evidence for spontaneous generation has been found. However, from a scientific point of view, we cannot say at present that conditions never existed on the earth which might have resulted in the spontaneous formation of living organisms. Of course, even if we had convincing evidence that such a transformation did take place, and even if we could observe certain steps in the over-all process, it would not necessarily follow that we could ever duplicate the whole process and "create" life. Scientific knowledge can be built on many kinds of evidence. We have learned much about the planet earth without feeling the necessity to try to duplicate it! In this case, as in many others in science, making accurate models is sufficient for our purposes. In a sense, in spite of the dramatic stories about creating life in the popular press, making "models" of living systems is really what biochemists are hoping to accomplish.

Although Darwin himself showed admirable restraint in refusing to engage in speculations about the origin of life, other evolutionists did begin to publish hypothetical schemes for the process by which the primordial living thing arose. T. H. Huxley stated in 1868 that all that was involved in the origin of life was the arrangement of ordinary matter into a suitably complex relationship.[9] In Huxley's day, so little was known about the chemical nature of protoplasm that this amounted to a speculative hunch rather than a judgment based on scientific evidence. The development of biochemistry in the twentieth century has presented us with a huge mass

9. T. H. Huxley, "On the Physical Basis of Life," 1868, published in various collections of his writings, including *Autobiography and Selected Essays,* ed. by A. L. F. Snell, New York: Houghton Mifflin Co., 1909.

of evidence[10] and in doing so has had two opposing effects on theories of the origin of life. On the one hand, the elucidation of the chemical bases of many physiological phenomena has strengthened our mechanistic attitude toward living things and essentially destroyed the vitalistic approach to phenomena. That is, the goal of biochemistry is the description of biological processes in terms of the laws of physics and chemistry; steady progress toward that goal has made the concept of a "vital force" peculiar to living things something of a historical curiosity among practicing biologists. A mechanistic philosophy of biology leads naturally to theorizing about the origin of life: if physico-chemical forces can account for the operation of biological processes, why should they not be able to account for the origin of such processes?

On the other hand, however, biochemistry has revealed that living cells are almost unimaginably complex chemical systems and that even the microorganisms and other morphologically simple forms of life also show this tremendous complexity. That is, biochemistry has actually made the problem of bridging the gap between the non-living and the living more formidable. It is true that the discovery of viruses has provided a sort of intermediate stage between the two, but viruses are still far too complicated for chemists to be able to synthesize in the near future — and yet they are far below the level of complexity of a complete living cell. The discovery of this complexity has made the concept of a sudden natural formation of living organisms from the inanimate mineral matter of the earth's crust scientifically unthinkable, and leaves as alternatives only a completely supernatural event inaccessible to scientific investigation, or some kind of pre-biological evolution over long periods of geological time. Current scientific interest is therefore directed toward possible mechanisms for such a gradual process, and toward ways of demonstrating or inferring the actual occurrence of the process. Data from many sources — from astronomy, geochemistry, paleontology, as well as from microbiology and biochemistry — have a place in this concept of pre-biological evolution.

An outstanding contribution to this mode of thought has come from the Russian biochemist, A. I. Oparin, whose book, *Origin of Life,*[11] was first published in 1936. Oparin emphasized that the gap between the non-living and the living must have been gradually bridged and proposed some definite mechanisms by which complex molecules could have been formed before there were any living things on the earth. Most of the current writers on this subject have been influenced by Oparin's work, although many of his

10. For details of the biochemical problems involved in this discussion, see a modern text such as J. S. Fruton and S. Simmonds, *General Biochemistry,* 2nd Edition, New York: John Wiley & Sons, 1958.
11. A. I. Oparin, *Origin of Life,* translation with annotations by S. Morgulis, New York: MacMillan Co., 1938.

ideas have been modified in the light of more recent biochemical and geochemical discoveries. At present there is considerable difference of opinion about details of various stages of the over-all process.[12] However, the assumed stepwise nature of the process, regardless of the specific details, renders of little value the calculations of Guye and Lecomte du Noüy on the extreme improbability of the formation of a protein molecule within geological time.[13]

The nature of driving forces which can bring about increasing complexity is of course the central problem for evolutionary theory and is even more serious when the theory is pushed back to include pre-biological evolution. We expect spontaneous natural processes to go in the direction of *decreasing* complexity. Our everyday experiences of the tendency of energy differences to be leveled off, seen in the pull of gravity on objects raised to higher potential energies and the transfer of heat energy from hot objects to their cooler surroundings, have been summed up in a precise statement known as the Second Law of Thermodynamics. One way of stating the Second Law is to say that in a closed system, one in which energy does not go in or come out, the energy of the system tends to spread at random throughout all parts of the system. The measure of this randomness is given the name "entropy." That is, in a spontaneous process energy will be distributed more evenly throughout a system, and we say that the entropy of the system increases. Perhaps the most characteristic property of living things is their ability to reverse this trend toward random distribution of energy by actually concentrating energy in the form of complex chemical compounds and delicate structural arrangements. In doing so, they do not violate the Second Law because they are not closed systems: energy constantly flows through a living organism, preventing it from "running downhill" to a state of thermodynamic equilibrium. Once a living thing exists, it obviously possesses mechanisms for degrading energy metabolically (the source of energy being sunlight for green plants and the chemical energy of nutrients for other organisms) in order to maintain its low entropy state. Evolutionists argue that these existing mechanisms are sufficient to account for increasing phylogenetic complexity; critics of evolution argue that all that can be accounted for on this basis is the ontogenetic increase in complexity of a single individual.[14] Biochemistry has not yet fully de-

12. For example, see G. Wald, "The Origin of Life," *Scientific American,* Vol. 191, no. 2, pp. 44-53 (Aug., 1954); S. Kirkwood, "The Origin of Life," *Chemistry in Canada,* Vol. 8, no. 2, pp. 25-30 (Feb., 1956); Discussions by J. D. Bernal, J. B. S. Haldane, N. W. Pirie, and J. W. S. Pringle, *New Biology, No. 16,* London: Penguin Books, Ltd., 1954.
13. P. Lecomte du Noüy, *Human Destiny,* New York: Longmans, Green & Co., 1947; Paper-bound, New York: Signet Books, New American Library, 1949, pp. 30-39.
14. R. E. D. Clark, *op. cit.,* Chapter VIII, "Evolution and Physics."

scribed this living metabolic machinery and its complete description may always elude us; but at any rate, we definitely have only ordinary physics and chemistry to work with to explain increasing complexity in a *pre*-biological realm. Is it at all unreasonable that increasingly complex organic compounds could have formed spontaneously and persisted in the early stages of the earth's existence?

Organic compounds were given their name because it was once thought that they could be formed only by the "vital force" within living organisms, but of course we have now learned how to synthesize them in the laboratory. It is true that the giant molecules of protein and nucleic acid on which all life seems to depend have not been synthesized without the use of systems derived from living cells. It is also true that the Second Law implies that complex molecules should be less stable than simple molecules as a general rule. The more chemical bonds in a molecule, the more chemical energy it has and the more tendency to react and be degraded into simpler molecules. However, if it were not possible to find conditions under which large molecules were more stable than smaller ones, we would never be able to synthesize plastics and other polymers in the laboratory! And the synthesis of the polypetide and polynucleotide structural units of proteins and nucleic acids *has* been achieved in the laboratory. Such syntheses are accomplished by making the small molecules very reactive, or in other words by providing them with so much chemical energy that when they react to form larger molecules the total amount of energy in the large molecule is less than the sum of the energy in the original small molecules. In this way, the energy of the whole system is "running downhill" in perfect accord with the Second Law, but the resulting products are more complex than the starting materials.

The question is, have there ever been conditions on the earth's surface in which a supply of reactive molecules could have been built up, which would then react with each other to form larger and more complex molecules? There is still considerable disagreement about the stages the earth went through before life appeared on it, but Nobel laureate H. C. Urey has postulated an entirely different type of atmosphere from our present one as characteristic of the earliest stages of the earth's history.[15] The main feature of this pre-biological atmosphere, according to Urey, was the presence of hydrogen and the absence of oxygen, giving it reducing rather than oxidizing properties; oxygen was originally in the form of water and metallic oxides, carbon in the form of carbides and methane, nitrogen possibly as ammonia. Urey believes that such conditions, while unfavorable to life as we know it today, would have promoted the accumulation of or-

15. H. C. Urey, "On the Early Chemical History of the Earth and the Origin of Life," *Proc. Natl. Acad. Sci., U.S.*, vol. 38, pp. 351-363 (1952).

ganic compounds which might later have been utilized in the first living organisms. These ideas about the extent of extreme reducing conditions on the earth have been questioned,[16] but they have led to some very interesting experiments.

A graduate student of Urey's, Stanley L. Miller, tested his hypothesis in 1953 by making up a "sample" of the proposed primitive atmosphere, circulating methane, water, ammonia, and hydrogen in a closed system through an electric arc. When he analyzed the aqueous solution at the end of several days, he found it to contain several different organic compounds, including some of the amino acids usually found in proteins.[17] Since then, many investigators have performed similar experiments using various sources of energy other than an electric discharge, and have shown conclusively that many types of organic compounds can be produced.

Of course, the demonstration that organic molecules must have existed before there were living things is a long way from demonstrating that such molecules actually became arranged in increasingly complex ways, finally arriving at a degree of complexity which made life possible. In fact, at present this stage in the over-all process is the most speculative of all. It has been shown, however, that some rather simple molecules have the property of speeding up or "catalyzing" specific chemical reactions, even though their catalytic efficiency is many orders of magnitude lower than that of enzymes, the complex biological catalysts found in all living things today. It is at least conceivable that molecules or molecular aggregates which could catalyze any of the steps in their own synthesis would accumulate at the expense of others, and that given the randomness characteristic of molecular interactions and sufficient time they could even be converted into more efficient catalysts.[18] It is also conceivable that clusters of catalytic molecules — primitive metabolizing systems — might have arisen in such a way and persisted, later to be combined into more complex sub-living systems and eventually into such complete systems that we would regard them as actually living.[19] Our evidence for the stability of sub-living metabolizing systems is relatively recent, but it is now apparent that such sub-units, isolated from disintegrated cells, can carry out the synthesis of proteins and possibly of nucleic acids as well. Thus the gap between the non-living and the living

16. W. W. Rubey, "Development of the Hydrosphere and Atmosphere, with Special Reference to the Probable Composition of the Early Atmosphere," *Geological Society of America, Special Paper No. 62,* pp. 631-650 (1955).
17. S. L. Miller, "Production of Some Organic Compounds Under Possible Primitive Earth Conditions," *J. Am. Chem. Soc.,* vol. 77, pp. 2351-2361 (1955).
18. Melvin Calvin, "Chemical Evolution and the Origin of Life," *American Scientist,* vol. 44, pp. 248-263 (1956).
19. N. W. Pirie, "The Meaninglessness of the Terms Life and Living," in J. Needham, and D. E. Green, *Perspectives in Biochemistry,* Cambridge: Cambridge University Press, 1937, pp. 11-22.

is being bridged from both sides, by demonstrating that simple compounds will react to form more complex ones under conditions which may have existed for long periods of time on the earth, and by demonstrating that reactions formerly known only in complete living cells can be carried out by much simpler systems.

Will scientists ever be able to create life in the test-tube? Probably not, at least in the foreseeable future, if by "life" is meant something as complicated as a cell. But there does seem reason to believe that we can gain enough understanding of the process by which life actually did arise on the earth to duplicate some of the steps in the laboratory. That is, we may be able to form a relatively simple system which can use some source of energy — sunlight, perhaps — to maintain itself and even reproduce itself. Of course, in the biologically competitive world in which we live, such an inefficient system could not compete successfully with the highly selected organisms already present, so would undoubtedly have an ephemeral existence outside of the test-tube.

Now, where does all this leave the Christian? Shall we take the position that such a thing is impossible, or that such attempts are the work of Satan? Do the creation passages in Genesis state categorically or imply that the life which God spoke into existence necessarily appeared suddenly? Or can we accept the scientific investigation of the origin of life as a way of gaining greater insight into the creative activity of God?

Obviously, there will be differences of opinion among Christians about these questions. I have tried to point out the current trends in scientific investigation and speculation in this field. It is plain that reputable scientists have faith that life arose from inanimate matter through a series of ordinary physico-chemical processes. If Christians cannot accept this idea, even as a legitimate working hypothesis, there will inevitably be conflict with Science over this issue. To me, such conflict is needless. The emphasis of the creation passages in Genesis is primarily on the Creator Himself, with a minimum of detail about mechanisms He may have utilized in the creation of life. Unless one takes an arbitrary view of these passages, I cannot see why a concept of God bringing life into existence through gradual processes is any less valid than that of the sudden creation of life. Not all evangelical Christians have assumed a *sudden* act of special creation to account for discontinuities in the paleontological record. However, the gap between non-living matter and life has always seemed so large that most Christians have probably made the assumption that at this point an extraordinary and sudden creative act was performed. But if there is good evidence that God has worked through process here, are we justified in clinging to this *assumption* as the only possibility?

It seems to me that there is considerable danger in assuming a sudden

supernatural intervention as the only possible explanation of an observed event which, on the basis of our present knowledge, we regard as highly improbable. A Christian must be as ready to acknowledge God as the ultimate cause of phenomena he can understand scientifically as he is to say, "God must have done this," when he comes up against a phenomenon whose mechanism he cannot understand. If he cannot do this, he will find his concept of God shrinking instead of growing with his understanding of God's creation.

Scientific investigations must always be mechanistic in their outlook, because it is only in this narrowed frame of reference that the scientific method can operate.[20] It is probably true that many non-believers have welcomed mechanistic interpretations of phenomena, and especially of the origin of life, feeling that such interpretations would make belief in God unnecessary. Such an attitude indicates a basic misunderstanding of the Christian idea of God and the way by which we come to know Him. Belief in God is never forced upon us, no matter what our level of understanding of natural processes; if this were not so — if the study of nature made it impossible *not* to believe in God — then knowing Him would be based on intellectual sophistication instead of on faith, and the Scripture makes it clear that "without faith it is impossible to please Him." Knowledge of God is not synonymous with knowledge of His creation; if it were, salvation would be bestowed only on those trained in natural science! God cannot be found by scientific knowledge any more so than He can be found by scientific ignorance. The mechanistic view of how God works in nature and the theological view of His purpose in working in nature are complementary to each other and not antithetical.

The problem of the origin of life illustrates this situation. How did life originate? The Christian may answer unhesitatingly, "God created it," but he should realize that he is not giving a descriptive answer. The scientist may say, "We are not yet certain, but probably it happened something like this —," and outline the current mechanistic theories and the evidence on which they are based; but even if he could describe precisely the mechanisms by which life came into existence, his answer could also never be complete by itself. And if we should be able to produce some prototype of a living organism in the test-tube, what more will we have done than to copy the Creator's handiwork?

At any rate, whether life can ever be created in the test-tube or not, there is tremendous interest in the origin of life among scientists today,

20. See John Baillie's address to the British Association meeting in Edinburgh, 1951, entitled, "Natural Science and the Spiritual Life," publ. in full by Oxford University Press, and in shortened form as "Christianity in an Age of Science," in *Science and Faith Today,* London: Lutterworth Press, 1953.

and it is obvious that there will be acceleration of theoretical and experimental work in this field. No one can accurately predict the extent of new discoveries or the effects they may have on our concepts of nature and of life itself. Must Christians regard this activity with suspicion and fear? May we not rather take part in this great adventure of discovery with enthusiasm and joy, confident that we are in a sense thinking the Creator's thoughts after Him as we learn to understand His ways? After all, we believe that God has created life — why should we not be interested in *how* He created it?

NEAR-MAN OF SOUTH AFRICA

HENRY W. SEAFORD, JR.

The worst possible approach to a discussion of evolution is an examination of fossils closely related to man. There is good reason for this. In the first place, a normal citizen delights in contemplating knights and kings scattered here and there in his family tree. Should he suddenly descry a monkey frolicking in its branches, his ego would suffer such violence that he would be wont to explain its presence as fantasy. Virtually, Thomas Pennant did this when in 1791 he commented on Linnaeus' classification of Mammalia: "I reject his first division which he calls Primates or chiefs of creation; because my vanity will not suffer me to rank mankind with Apes, Monkeys, Macaucos . . . the companions Linnaeus has allotted us . . ." (quoted in Gregory, 1949). Mr. Pennant's honesty is to be admired. For him, arguments to prove man has no relation to animals are not of prime importance. He faces the problem squarely: he does not wish to call himself a monkey's nephew.

Secondly, the fossil record showing ancient human and pre-human forms is too spotty to inspire the confidence one needs to state categorically: This is *the* way man evolved. After the lapse of 178 years, Mr. Pennant's vanity has not been decisively infringed. According to one of the world's most distinguished paleontologists:

> The study of human origins is an attempt to determine a historical sequence of events from inadequate data. It is evident to all that the data are inadequate at present. It is highly probable that they will always be inadequate, because they must remain ambiguous in the sense that they will be consistent with more than one possible interpretation (Simpson, 1951).

In other words, the missing link which people have talked about for the better part of a century will never be discovered, for each time a new human-like fossil is brought to light, it can be pretty well pigeon-holed according to one's personal notions. The skeptical layman is always able

to reassure himself by calling to the scientist's attention that he has not yet found the missing link. What he really means is something quite different from what he thinks he means. The real missing link (i.e., what it would probably take for him to accept human evolution) is the vast array of data concerning the history and dynamics of living organisms. For the scientist, on the other hand, it is just another link which he tranquilly fastens to existing links of evidence in his theoretical chain of reasoning, knowing that "Science consists not in absolute knowledge, but in the statement of the probable on the basis of our present — invariably limited — acquaintance with facts" (LeGros Clark, 1955).

In 1859 Charles Darwin challenged the traditional interpretation of the Genesis account of Creation, which had been promoted by man's tendency to consider himself distinct from all animals. Some Christians, assuming all along that Genesis gives a literal description of how human bodies were made, considered Darwin's theory anti-scriptural. One cause of this reaction might lie in the frequent, implicit procedure of interpreting the Bible according to the scientific background acquired by the interpreter. A case in point is Martin Luther's assailing Copernicus. A standardized product of the middle sixteenth century's understanding of the solar system, Luther spoke without fear of contradiction from what he thought to be the authority of God's Word:

> People gave ear to an upstart astrologer who strove to show that the earth revolves, not the heavens or the firmament, the sun and the moon. Whoever wishes to appear clever must devise some new system, which of all systems is, of course, the very best. This fool wishes to reverse the entire science of astronomy, but sacred Scripture tells us that Joshua commanded the sun to stand still, and not the earth (quoted in Moody, 1953).

Notice especially how the intrepid Reformer felt security from his knowledge of the "science of astronomy" as he proclaimed the meaning of Scripture. When the public is as thoroughly convinced of the theory of evolution as it is of the truth of Copernicus' *De Revolutionibus Orbium Coelestium,* apparent contradictions between organic evolution and the Bible will belong to history. Future generations will regard arguments against the basic postulates of *The Origin of the Species* as meaningless and will smile at us with the same understanding as we at Luther for his tirade against that "upstart astrologer."

At this juncture someone will observe that evidence supporting Copernicus is more convincing than that upholding Darwin. In many respects, this is true. On the other hand, for a theory to survive in the critical age in which we live, it must possess some *raison d'etre.* What is it about a theory which makes it persist? A scientific theory has been compared to a work of art (Bronowski, 1958), not only from the emotion conveyed by its unity, but also because it represents a particular synthesis chosen by its author from various alternatives. When man is able to unite disparate elements

of his surroundings into a meaningful whole, he has created a work of art. The beautiful synthesis displayed in Darwin's theory of evolution has inspired the fervid response of scientists for a century, furnishing them impetus to describe the dynamics and history of living things. Unless someone can propound a more useful theory — a better working hypothesis — organic evolution is here to stay. As Dr. Conant (1951) has observed:

> A conceptual scheme is never discarded merely because of a few stubborn facts with which it cannot be reconciled; a concept is either modified or replaced by a better concept, never abandoned with nothing left to take its place.

In the case of evolution there have been, and still are, many stubborn facts. Even when the very foundation of Darwin's hypothesis had never been observed in nature, one dauntless pioneer wrote in 1922: "That particular and essential bit of the theory of evolution which is concerned with the origin and nature of species remains utterly mysterious" (quoted in Mayr, 1950). In those days it was thought that a species was a *type* of animal. Apparently, for a new species to be formed, a female would have to give birth to a completely different *type* of animal — doubtlessly to her chagrin! No longer is a species considered a *type;* it is rather a *population* manifesting a certain frequency of genes. Change in this frequency with concomitant change in the organisms (not always immediately expressed in the case of recessive genes) can occur:

1. By mutations in the genes and/or their arrangement in the chromosomes;
2. By change in the environment which favors certain genetic characteristics;
3. By chance loss of genes, especially in small, isolated populations.

Investigation of the dynamics of these processes is limited to predominantly horizontal phenomena in our present position in spacetime; observation of their having occurred is vertical and limited only by the rate with which specimens are discovered. Pointing out the hard facts in modern genetics is beyond the province of this paper. It is a fact, however, that new species can be formed. When this occurs, the specific difference between two groups can become a foundation for further differences, resulting in progressive dissimilarity between the two original groups. The higher categories of differentiation are only logical projections of an observable process of speciation. The following is a brief, and in many respects grossly inadequate illustration of the process.

Animals of population A look like one another because they draw their constituent genes from a single gene pool. Animals of population B resemble those of population A, but since the two populations are breeding isolates, their respective gene pools have different frequencies of genetic variants. Similarities between the two reflect the bulk of genes they share

in common. Population C is obviously the same general form of life as populations A and B, but there are many differences between the former and the two latter. Variations in gene frequencies, then, are greater between population C and the combined populations A-B than those between the two components of the latter. Differences in gene frequency between these associated forms of life are evidence of natural selection, the *sine qua non* of organic evolution. The logical assumption of the taxonomist after he has made his classification is that A-B-C were formerly a single gene pool. First to be isolated from the parent group was population C which followed its peculiar evolutionary course while the A-B population diverged in another direction. More recently (because they still share much common genetic material) population A separated from population B, and their new autonomous gene pools have barely begun to follow separate adjustments to their respective environments. Speciation, thus, begins with race or sub-racial differentiation and proceeds to higher taxonomic categories as time goes on. It should be noted, however, that evolution does not *have* to occur. It does occur when an environmental opportunity (e.g., change of climate and/or food supply) favors an existing genetic potential (e.g., mutation) for change.

Non-evolutionists will feel encouraged by the fact that virtually nothing is known of the actual operation of natural selection in human populations. That man has culture gives a somewhat different aspect to his evolution as compared with that of other animals, but geneticists have well-founded reasons for believing that human populations are still influenced by natural selection (Dobzhansky, 1956; Neel, 1958). It has been alleged that man descended from monkeys. A moment's thought will reveal the impossibility of such a zoological phenomenon. Our zoos are filled with the end products of millennia of biological change — monkeys, apes and (on the other side of the bars) men. Obviously if each of these forms has been undergoing changes of its own, one cannot be ancestral to another. What the paleontologist finds as he goes back through time is that forms — for example, ape and man — which are divergent on the modern level appear to have precursors which become more and more like one another until it seems most logical to postulate that both arose from a common ancestor. In this light, we might as well say that apes came from human-like ancestors as to say the reverse. This would restore a goodly measure of pride to us, while, incidentally, giving a terrific boost to the morale of the ape!

If organic evolution has been operating in spacetime, taxonomic anomalies (from the point of view of classifying modern animals) can be expected as paleontologists inspect the fossil record. Should certain animals at the close of the Paleozoic (just before the Age of Reptiles) be classified as amphibian-like reptiles or reptile-like amphibians? In the Mesozoic (just

prior to the time mammals and birds became dominant) were there mammal-like reptiles or reptile-like mammals, bird-like reptiles or reptile-like birds? And at the beginning of the Pleistocene (the Age of Man) were certain South African primates ape-like men or man-like apes? To investigate the latter case, let us listen to the story of Near-Man and his kind known to the world of science as the *Australopithecinae*,* ". . . by far the most important discoveries which have so far been made in the field of human palaeontology" (LeGros Clark, 1948).

History of the Discovery

In 1925, Professor Raymond Dart, an anatomist in Johannesburg, published the account of a skull which had been discovered in Taungs, South Africa. "The specimen is of importance," wrote Dart, "because it exhibits an extinct race of apes *intermediate between living anthropoids and man.*" A former medical doctor turned paleontologist examined the startling find and immediately became Dart's staunch supporter. This man, Robert Broom, was destined to discover personally — with remarkable good fortune — many additional specimens, as well as to champion the view that *Australopithecus* possessed many human-like characteristics. Opinions in Europe and America were more conservative. Some decided that the South African fossil was a chimpanzee; others, a small gorilla. The distinguished American vertebrate paleontologist, Alfred S. Romer, saw the original specimen and in 1930 wrote that it resembled a chimpanzee more closely than any other animal, but, whatever it was, it was *not* a chimpanzee! One by one scholars gave credence to Dart and Broom's views.

Much of the debate was due to the fact that the skull was that of a juvenile of only five or six years — judging by human standards. Hrdlicka, the famous American anthropologist, saw the skull in 1925 and said that adult specimens would have to be found before the affinities of *Australopithecus* could be determined. Eleven years later, Dr. Broom found adult remains. The evidence continues to multiply. Four years ago there were fragments from some 65 individuals not counting isolated teeth (Robinson, 1954). Not only skulls have been found, but also parts of the postcranial skeleton including fragments of thigh bone, and parts of arm and collar bones found together in close association with a skull. An ankle and heel bone have been found, as well as a vertebral column and over 500 teeth. Although debate over the taxonomic position of these animals continues to some degree, more authors now recognize the strikingly human features of the australopithecines and place them in the family Hominidae with man.

Dating of Near-Man

For the most part, the fossiliferous deposits containing Near-Man re-

*My work under Prof. W. W. Howells at Harvard has significantly influenced my handling of this subject.

mains are breccia-filled caves which have been formed in the dolomite hills of South Africa. The fossils came to light as mining companies indelicately blasted for limestone. At Taungs, however, the geological situation is different in that the first australopithecine skull was found in breccia filling a large fissure which had formed in the earliest layer of a vast extension of travertine — so extensive, in fact, that it has been commercially exploited for nearly four decades. Since very little tufaceous limestone is being formed along existing streams in the region, and since dust-bowls are now a problem, such massive beds of travertine must have been formed when the climate was wetter than it is today. A likely time for this to have transpired was during a wet phase at the beginning of the Pleistocene (Oakley, 1957).

It was formerly thought by Broom and Robinson that these early hominid remains dated from Pliocene to middle Pleistocene, but the weight of current evidence indicates post-Pliocene. Oakley has suggested that during the Pliocene, semi-arid Africa was drier than it is today, and since the travertine did not accumulate prior to the Pliocene, it must have done so during the first wet phase at the base of the Pleistocene. Of course, in order for the skull to be found in a fissure filled with fossiliferous breccia, the travertine had to be first deposited after which the fissure was formed. The actual event of the little skull's rolling into obscurity for nearly a thousand millennia must have occurred during the dry period following the first great African Pluvial (Oakley, 1957).

Dating secondary deposits, as those containing australopithecine remains, is not a simple matter. On the southeastern coast of Africa there are raised beach lines, but no one has been able to correlate these with times so ancient as when Near-Man lived. Nor has the ingenious geological device of studying knickpoints of rivers (to indicate past shifts of sea-level) yielded pertinent information (Barbour, 1951). A promising solution to the problem of dating deposits is the relating of African pluvials to glacier activity in Pleistocene Europe. It is thought that there must be some general relationship, even though there is really no solid evidence. No violence is done to present geological and faunal data, however, when the two are roughly equated in time. In all probability the two will be ultimately related (Cole, 1954).

An ambitious and painstaking study has been made of sand grains in the australopithecine cave deposits (Brain, 1957). When the caves were first formed they had no opening to the surface. Later a small aperature eroded through. Obviously, at this second stage some outside matter including bones could then accumulate in the cave which had formerly contained only deposits of dripstone. But not until the cave entrance was large enough to allow a representative sample of outside material to accumulate was it of use for this study. By placing samples of this deposit

in dilute acid, Mr. Brain was able to extract a residual fraction from the lime cement. A grading analysis was then carried out and the various percentages of residual material from fine gravel to clay could be ascertained. The percentages were found to be quite comparable with modern dolomite soil of the region, but one difference was discovered: the ratio of chert to quartz. The chert is of local dolomite origin, while the quartz was blown in from the west during dry, windy periods. The fossil deposits contain a greater percentage of quartz, thus indicating a drier climate. Even the intensity of dryness can be ingeniously calculated, for Brain found that modern soils in drier sections of South Africa have a high percentage of wind-worn, frosted particles of sand. By examining the fossil soils — if one has patience to count a few thousand grains of sand — it is possible to determine the intensity of dryness from one period to the next. Geology is thus able to distinguish climatic fluctuations, but paleontological evidence is necessary to arrange these in sequence.

Although the fossil faunal remains do not furnish irrefutable proof as to the precise age of australopithecine deposits, a bit of paleontological sleuthing comes up with most suggestive evidence. In the first place there are some similarities between the basal Pleistocene faunal assemblage of northern Italy with that of South Africa in the days of Near-Man (Barbour, 1951). Our problem would be solved at the outset if these two faunas could be equated in time, but the situation is complicated by the fact that South Africa appears to have been a cul-de-sac for animal forms which outlived their northern relatives. An archaic hyena, for example, was a good type-fossil for the middle Pliocene of Europe and Asia, but in South Africa survived into Pleistocene times. Among other archaic forms which shared the region with Near-Man was Chalicothere with hefty claws instead of hoofs, and on top of a giraffe-like neck, a big skull of rhinocerus proportions. Also his front legs were longer than the rear ones. Other bizarre types were wart-hogs of nearly rhinocerus size, baboons as big as gorillas and sabre-tooth tigers. Beneath the sun with these "fearsome beasties" basked the phlegmatic hippopotamus which, one might fancy, because of his sensible pace survived unchanged to modern times.

Another most promising contribution to the understanding of South Africa's paleontology has been made only recently (Ewer, 1957). The logic of the approach goes like this: When the Pliocene merged into the Pleistocene in this region there was no sudden change in animal life. Forms which had existed for a venerable number of years did not suddenly vanish from the face of the earth. In like fashion, modern animals did not suddenly come into existence. In order to arrive at some conclusion about the age

of the fauna in the australopithecine deposits, one must determine whether the fossil assemblage is one composed of modern forms with a few diehards hanging on, or, to the contrary, whether the animals are principally archaic forms with a few modern ones making their debut. By determining the percentages of numerous species and genera in the deposits, the latter situation appears to have been the case. Furthermore, a comparison of the southern fauna with better dated sites in Africa strongly indicates an early Pleistocene age. Dating australopithecine remains by measuring their fluorine content is of little value in this region since fluorine ions do not easily pass through the surrounding calcite in which these fossils are imbedded. This method, however, apparently suggests that the animals were of Pleistocene rather than Pliocene age (Oakley, 1954).

Characteristics of Near-Man

Near-Man characteristically walked on his hind legs as we do. He was not quadrupedal like monkeys,* nor was his skeleton specially constructed for swinging from one tree to another in ape fashion. He was a little fellow. One student (Robinson, 1956) has calculated his weight as a bare 50 pounds, while another's estimate (Straus in Garn and Lewis, 1958) would double this, making him of chimpanzee proportions. For the massive size (larger than ours) of his jaws, molars and bicuspids, he had an exceedingly small head. His jaw protruded in front, not quite so much as the gorilla's, but his slight forehead (in some specimens) detracted from his beastly appearance. At least he had no threatening canine teeth as does the ape. With a pelvis about the size of a modern Bushman's, his hips would have been disproportionately large from our point of view.

Near-Man lived 2000 miles away from the nearest modern anthropoid, and since the climate is substantially the same today as it was then, this would attest his greater intelligence in being able to survive in the "untoward environment" of the Kalahari region (Dart, 1925). In his incessant search for food he roamed the treeless terrain looking for edible roots (detected from the type of wear on the molars), dined frequently on succulent antelope and knew the ways of the "feeble folk" among the rocks — the conies. Dart (1949) firmly believes he hunted baboons with clubs of ungulate leg bones. Another view (Washburn, 1957) has it that he himself was the prey of carnivores. Notwithstanding, Dart (1958) still thinks Near-Man had the upper hand. In all, to meet this little fellow during a camping trip would be quite an experience!

Let us now consider the skeletal anatomy of these creatures in some detail. There will be four main divisions: skull, teeth, limb bones and hip.

1. *The Skull.* Modern man has an average cranial capacity of 1350

*This possibility has been considered (Kern and Straus, 1949), but appears most unlikely in the light of the creature's gross skeletal characteristics.

cubic centimeters, but capacities up to 2000 cc. are on record. At the other extreme, Anatole France won a Nobel Prize with a mere 1100, and the great French statesman, Leon Gambetta, possessed political perspicacity in an even smaller head. The lowest cranial capacity for modern races is 860 cc. Anything appreciably less would be pathological (Krogman, 1948). One fairly complete skull of Near-Man (*Plesianthropus*) has a capacity of only 482 cubic centimeters, and the skulls of the whole group range from about 450 to perhaps over 700 (LeGros Clark, 1955). Heads of this size are far below the modern human range and are comparable in size to those of gorillas, the largest of which can attain 685 cc. Relative to the small body of these creatures, however, the ratio of brain weight was probably greater than that of the gorilla (LeGros Clark, 1951, 1955; Vallois, 1955), even though one author (Ashton, 1953) has claimed this conclusion is based on meager evidence.

There have been some doubtful estimates of Near-Man's brain size. Broom and Robinson (1952) calculated the cranial capacity of one specimen could have been over 1000 cc. This would, if true, place the animal in a fully human category — a potential Nobel Prize winner. Other workers (LeGros Clark, 1951; Ashton, 1953; Grassé, 1955) take strong exception to this estimate which is based on judging the size of the head from that of the jaw. Probably of lesser error was Dart's attempt to prove the old adage that "two heads are better than one." He estimated the capacity of a skull represented only by its posterior portion (*Australopithecus prometheus*) by placing it with the frontal portion of another (*Paranthropus robustus*). In spite of these few examples of over-enthusiastic treatment, there is abundant evidence proving that Near-Man's brain was hardly larger than that of a gorilla.

It was this sub-human head which largely influenced the late Professor Hooton (1954) to regard *Australopithecus* an ape. Other ape-like features are: massive jaws, a bony crest on top of the skull (on some specimens), heavy brows, flat nasal region and the presence of a palatal suture. Near-Man's simian features have led some systematicists to place him with the apes (Simpson, 1945; Vallois, 1955). Others recognize that the australopithecines are evidence that the post-cranial skeletons of hominids, allowing them to walk erectly, evolved more rapidly than the enlarging of their brains. Therefore, the *Australopithecinae,* considering their overwhelmingly human aspect, should be classed as hominids in spite of their small brains (LeGros Clark, 1955; Heberer, 1956). Let us now examine the human-like features of these skulls. So close is *Australopithecus* to man that if certain fragments of his skeletal remains had been found alone, they would have been considered sapient.

Dart (1925) immediately noticed the forward position of the foramen

magnum, the large aperature in the base of the skull through which the spinal cord passes just before it merges into the medulla oblongata, and postulated the upright posture of Near-Man. Its forward position indicates that the skull was more balanced on the vertebral column than an ape's skull in which the foramen magnum is located more posteriorly causing most of the weight to hang out front. My foramen magnum — and yours too — has a forward position and, instead of facing posteriorly as it does particularly in old apes, it faces slightly forward. Near-Man's faced downward and did not rotate posteriorly with age (Cornwall, 1951). The occipital condyles, little knobs which articulate with the atlas of the vertebral column, are not so far forward as in modern man, or even in one of the earliest forms of man (Pithecanthropus), but their position in relation to the auditory opening is of hominid appearance (LeGros Clark, 1955). Suspicion that this creature walked like man is cogently corroborated by the appearance of muscle markings on the back of the skull. Since most of the ape's skull is in front of the fulcrum point provided by the occipital condyles, he needs strong muscles attaching high on the back of the skull for counterbalancing leverage. Man, with his balanced head, has no need for such an arrangement, and neither did Near-Man (Broom, Robinson and Schepers, 1950).

The brain case of Near-Man tends to be situated above the face as in man, not behind it as in apes. The mastoid processes, which are little pyramidal protrusions behind and below the auditory opening, are well developed in man and Near-Man, while in apes they occur only sporadically and are of different configuration. With the exception of one australopithecine specimen, the details of the notch where the lower jaw articulates with the calvarium are human-like. This mandibular notch in humans is quite well defined, and located just anteriorly to it is a prominence down which the condyloid process of the mandible slides when the mouth is opened and/or when the rotary motion of chewing takes place. The ape does not chew in this fashion — his interlocking canine teeth add to his inability — and possesses a more opened notch with a pronounced posterior protrusion. This post glenoid process does not allow the tympanic bone to form the back wall of the mandibular notch as it does in hominids. Although most authorities concur with the view that this feature of the australopithecine skull shows a human aspect, at least two critics (Ashton and Zuckerman, 1954) have located various gorilla skulls which they think are similar to Near-Man in this respect, and some human skulls which have shallow notches. A hasty appraisal of the photographs presented by these authors leaves me with the impression that the total aspect of some of the pongid mandibular fossae does not appear typically human, even if there are some details which might diverge in that direction.

Although the slight forehead (on some specimens) gives a human appearance, protruding brow ridges at its base are heavier than those of modern man; nevertheless, hominid frontal sinuses are present (Vallois, 1955). Bones comprising the orbital walls come together in hominid fashion. Whereas the skull vault in apes is not so thick as one might imagine (it is protected by muscle), that of Near-Man is quite thick and enclosed brains of greater complexity than the former (Broom *et al,* 1950; Le Gros Clark, 1955). Some Near-Man specimens reveal a slight chin development, which is in marked contrast to the receding symphysial region (where the two component halves of the lower jaw come together) of apes. These animals have a plate of bone reinforcing the jaw from the inside. This "simian shelf" does not appear in Near-Man. Gregory (1949) points out, however, that it was absent in the Miocene apes and is only slightly developed in female gorillas. The mental foramen, through which nerve and blood vessels pass, is usually single as in man, and not located so low on the mandible as in apes (LeGros Clark, 1955).

As for the skulls with the bony keel on top, LeGros Clark (1955) has pointed out that this feature does not necessarily indicate direct genetic control. It could be simply explained by the fact that australopithecines had such small heads geared to massive jaws operated, in part, by powerful temporal muscles. As the attachment of these muscles migrate up the side of the skull during growth, they eventually meet one another on top. If there is no more bone for attachment, a crest begins to form on top of the skull. (Juveniles do not have the crest.) Later in the evolution of hominid forms, as the brain became larger and the jaws smaller, there would not only be more room for muscle attachments, but no need for it in the first place.

2. *Teeth.* Persons who have looked askance at the activities of paleontologists have reassuringly recalled the case of *Hesperopithecus,* the purported New World fossil ape tooth which turned out to have belonged to a fossil pig instead. The incorrect conclusion was arrived at by statistical procedures. Using statistics, one student claims there is no significant difference between the teeth of australopithecus in "size and general shape" from present-day apes (Zuckerman, 1950). More convincingly, however, a professor of anatomy at Oxford, LeGros Clark (1953), has called attention to the inadequacies of statistical comparisons in studying taxonomic affinities and claims "the method of direct visual comparison is no less valid than the method of statistical analysis as a basis for statements regarding the *gross* quantitative differences in tooth structure which show no intergradation."

Using Professor LeGros Clark's list as a general guide, I shall point out the dental characteristics which both you and I have in common with Near-

Man. Each human feature will be followed by its pongid counterpart.

A. Permanent dentition.

1. Tooth rows arranged in form of parabola; canines and post-canine teeth arranged in more or less parallel rows forming U-shaped arch.

2. Small canines, blunt and spatulate shaped; large canines, conical and pointed.

3. No difference in size between male and female canines; marked sexual dimorphism.

4. Canines show wear on tips; wear on back and front side of canines which project well beyond level of other teeth.

5. No space between upper lateral incisor and canine into which lower canine fits (with exception of Pithecanthropus); diastema between upper incisor and canine.

6. Anterior lower premolar is bicuspid, with cusps usually same size; anterior lower premolar has one main, conical cusp for shearing purposes.

7. Molar cusps are rounded and located at edge of tooth; cusps slightly indented and pointed.

8. Molars often wear down to flat surface because of rotary chewing action; molars seldom worn to flat surface.

B. Milk teeth.

1. Lower canines blunt; lower canines conical and pointed.

2. First lower milk molar has four or five cusps more or less of equal size; first lower milk molar has one main, pointed cusp for shearing purposes.

3. Tooth rows in parabolic arch; U-shaped dental arcades.

Premolars provide an excellent taxonomic diagnostic between man and ape. Upper premolars in apes have three roots, whereas in modern man there is characteristically only one. Near-Man is intermediate with two roots, and crowns with two cusps of roughly equal size as in modern man. This contrasts with the single predominant cusp of apes. We have already noted the difference between the hominid and pongid cusp pattern of the lower anterior premolar. It is of further interest that the ape tooth has two roots as does the corresponding tooth in some specimens of Near-Man. For the most part, however, there is only one root with a well developed cleft. A good four-fifths of anterior lower premolars in modern man have a single peg-like root, and most of the remaining have single roots with a slight groove known as Tome's abnormal root. Rarely one appears with two roots (Robinson, 1956).

The excitement of parents over their child's latest milk tooth is paralleled among paleontologists upon discovering the fossil jaw of an im-

mature primate with at least canines and molars in place. Between man and ape there is a decisive difference in the lower first molar, and the first upper molar often has four cusps in the former and only two in the latter. The second lower molar has five main cusps among hominids and only one among pongids. In all these features australopithecines are completely hominid, while their lower milk canines — sharply pointed in apes — are nearly like the ones our little boy will soon painfully cut (Robinson, 1956). In LeGros Clark's study (1951) of the deciduous dentition of 223 juvenile apes, he concluded that there was no incident "in which the combination of hominid features seen in the dental arcade of the australopithecinae is paralleled, or even closely approached."

An unusual feature of australopithecine premolars and molars is their large absolute size. Relatively, the third molar is longer than the second, a unique situation which also prevailed in the mouth of Java Man. Peculiar to Near-Man is the accentuated size differential between small canines and incisors relative to massive post canine teeth, and the smaller size of the anterior premolar compared with the posterior (LeGros Clark 1955).

In treating the morphological aspects of australopithecine dentition in somewhat more detail than the cursory reader appreciates, I have endeavored to show the importance of a lowly tooth in determining — at least strongly suggesting — taxonomic affinities. Dr. J. T. Robinson (1956), who has followed in the fossil fact-finding footsteps of the now deceased Dr. Broom, thoroughly studied 448 permanent and 78 deciduous australopithecine teeth. He points out that the apparently slow evolutionary change and complexity of structure make teeth ideal for classifying Primates. Also, jaw and teeth being the most durable part of the skeleton are often the only remains left by the ravages of time.

Anatomically, what is man? How many features of man's skeleton need to be absent or changed to what degree before it ceases to be human? What sort of an animal is it that walks the face of our planet with a mouthful of human teeth (keeping in mind the slight divergences thereof in the case of Near-Man)? Earnest Hooton (1954), while quite impressed with the sapient features of the australopithecines, made his decision: "Because they lacked brains, they remained apes, in spite of their humanoid teeth."

3. *Limbs.* The reader will recall features of the skull which suggest the upright posture of Near-Man. Such a conclusion is corroborated by study of his limb bones. By human standards, the femur of *australopithecus* is small. Its bicondylar (the two "knobs" at the bend of the knee) width is comparable to that of an adult male chimpanzee, but also within the Bushman range. Relative to the bicondylar width, the lower end of the shaft is more robust than either of these. Human configurations are evinced in the manner the lower end of the femoral shaft slopes, the shape of the

articular surfaces and the marks for muscle attachments.

In the ankle bone (talus) we again encounter the blend of simian and human characteristics. On top, where it articulates with the shin bone, the dimension is only two thirds that of European measurements, but falls just slightly below a small Bushman counterpart. In spite of its small dimensions it is broad with an even curve as in man contrasting with the flat medial surface of gorillas and chimpanzees. At the other end, however, where "the ankle bone connected to the foot bone," the medial navicular surface flares out as in the gorilla and chimpanzee. This would permit a wider spread of the big toe and may well indicate a grasping foot similar to those apes. The other side of the navicular surface (its lateral extension) is of human configuration. One deduces from these features that Near-Man's foot, while good for walking and running, was more hand-like than ours (Broom and Schepers, 1946; LeGros Clark, 1948, 1951, 1955).

From what is known of the bones of the arm, one is able to see the same combination of human and non-human features. Starting from the upper arm (humerus) and proceeding to the hand, we find the lower end of a right humerus was very close to the same bone of the human skeleton. Some non-sapient aspects are: the slender, pointed medial epicondyle, the capitulum's forward location relative to the axis of the body and the alignment of the trochlea indicating a possibly limited capacity for flexion, but permitting a greater extension of the elbow than in man. The upper end of the right ulna does not have the prominent elbow (olecranon) found in apes, but is of human aspect.

For two years Broom noticed a capitate bone (located in the center of the wrist) embedded in the limestone matrix from which he was extracting australopithecine remains. He did not bother with it, for he thought it was too small to belong to anything but a baboon. When he finally extracted it for examination he found it to be very different from what he anticipated — he wondered then if it could be a human fragment! It is short and broad, not long as in the chimpanzee and gorilla. Details of the distal end where the third metacarpal articulates are of human configuration as are various other features of the bone. Withal, the capitate bone is not of totally human pattern. There is a concavity on the non-articular surface which in man is convex. In gorillas and chimpanzees this concavity is even more pronounced. The rounded head of the australopithecine capitate bone is oriented similarly to orangs, but differs from other apes and man. From a single phalanx one gains the impression that Near-Man's hand was quite distinct from that of the ape and approximated the human form even if longer and more slender than the latter. In all, it appears that Near-Man's hand was more flexible than the ape's, but not so dexterous as yours and mine (Broom and Schepers, 1946; LeGros Clark, 1948).

4. *Hips.* The first australopithecine pelvis was discovered in 1947 in direct association with limb, vertebrae fragments and a crushed skull. Two more have been found since then. Beyond all cavil, the form of the pelvis dispells any lurking shadow of doubt, which might still remain, that once upon a time in South Africa there lived little creatures which were uncomfortably human-like. In fact, one might speculate that if they were alive today public sentiment would prevent their being placed in zoos where people watch monkeys and apes with impunity.

Apes are able to balance themselves on their hind legs for a time, but their skeleton is not constructed for optimum performance in this position. The ape pelvis is essentially that of a quadrupedal animal. To make an ape pelvis human, one would have to turn the ilia so that the edges of the blade faced anteroposteriorly, and then spread it out to form attachments for the muscles used in bipedal progression. Washburn and Patterson (1951) have emphasized what a highly specialized piece of equipment the pelvis is for this form of locomotion. Of the pelvis of Near-Man they have this to say: "Among all mammals, the human ilium is approximated *only* in the South African 'man-apes.' If the pelvis only of these forms had been discovered, they would surely have been attributed to man, and possibly even to the genus *Homo.*" Professor Dart (1949a) considered the pelvis to be almost like that of a Bushman "not only in its shape and the relative proportion of its constituent parts, but even in its size."

Although the mechanical function of Near-Man's pelvis was quite similar to that of our own, some details are non-human, albeit non-ape as well. Dart (1949a) notes the shank of the ilium is thicker and the tubercle of the iliac crest less developed than in man. The ischium is thicker than its sapient counterpart and the configuration of its tuberosity is noticably different. The acetabulum (the socket into which fits the thigh bone) is subhuman in size (Broom and Robinson, 1952). An examination of some of these features suggests that the australopithecines might have been slightly less specialized than man for bipedal balance (Mednick, 1955).

In summary, LeGros Clark (1948) has called attention to the remarkable unity displayed by the australopithecine evidence.

> It is particularly interesting to note that the evidence derived from the study of different parts of the skeleton is reciprocally confirmatory. Thus, the nature of the wear of the permanent teeth leads to the inference that the temporo-mandibular joint was constructed on the human pattern, and this is borne out by an examination of the skull. The position of the occipital condyles indicates a poise of the head and a bodily posture which approximates to that of man, and this is confirmed by an examination of the limb bones. Further, the climatological evidence leads to the inference that the Australopithecinae were well adapted for terrestrial (and not for arboreal) life, and this is reflected in the conformation of the lower end of the femur. Lastly, the size and proportion of the brain, as well as the massive jaws, the large size of the molar and pre-molar teeth, and certain features of the reduced canine teeth, are definitely ape-like characters which,

> in combination with the more advanced characters of the skull and dentition, indicate a morphological status in some degree intermediate between the simian and human levels of evolution. In conformity with this is the remarkable combination of simian and human characters presented by the talus and os capitatum.

To this statement can now be added the nicely confirmatory evidence of the pelvis.

Culture and Near-Man

When William Jennings Bryan spoke on evolution at Harvard, an outstanding evolutionist, Earnest Albert Hooton, was called upon to introduce him. Considering the diametrically opposed views of the two men, the latter handled the situation with characteristic dexterity: "Man is said to be distinguished from the anthropoid apes principally by his power of articulate speech; if this is true, there is no living human being who has a better right to disclaim any relationship with the anthropoids than the speaker of this evening."

The concept expressed in Hooton's words is more than a polite formullation conjured together for the occasion; the real lacuna between man and all animals is not an anatomical one. His startling uniqueness consists in his ability to speak — the phenomenal manifestation of the ideation process, the basis of culture. Somehow this difference has been confused with man's anatomy in the minds of some who consider man's body to be very different from all animals. Actually the only prominent anatomical specializations man can claim are his feet (of all things!) and his relatively and absolutely large, well-convoluted brain. The uniqueness of his combined skeletal details, especially the pelvis, has been discussed above. We have seen, however, that some of these details have been exploited by an organism which is apparently not human. An animal of this sort is anticipated by the evolutionist as he "reads" the fossil record, and sees the ancestors of somewhat divergent modern forms merging together into a single form. If an australopithecine-like form is found in deposits prior to Pleistocene, it will be regarded as directly ancestral to present specimens of Near-Man and to man himself.

In the final analysis, then, the taxonomist will have to forsake his bones and teeth in distinguishing man from beast and appeal to culture — a phenomenon of a completely different kind. Professor Kroeber (1948) has suggested that culture may have entered the world by only a slight genetic mutation which gave to its possessors a desire to communicate ideas. Could this have been a retardation in the closing of the cranial sutures allowing the brain to take advantage of greater development? Whatever it was, it made that primeval hominid ready to receive the traumatic experience of grasping the ability to employ the ideation process. In connection with this hypothetical event, I often think of the experience of Helen Keller,

although I doubt the two are similar in kind. Ernst Cassirer (1954) relates that after a retarded childhood, she suddenly understood one day that words are not properties of the material objects they designate, but are symbols — the very stuff culture is made of. Instantaneously, by this single idea, she was reborn into a fully human world.

See how the image of God is reflected in man. Only man has language; only man has culture. It is from a current of ideas that culture manifests itself throughout spacetime in grinding stones and atom smashers, cave paintings and art galleries, proverbs and political palaver. Because the human mind is capable of ideas it is capable of creation — the ability to bring order from disorder. One might wonder if this faculty could be a microcosm of the macrocosm: ". . . the world was *created* by the *word* of God" (Hebrews 11: 3). Or more succintly, as Genesis majestically phrases this cosmic thunder: "And God *said,* 'Let there *be* . . . !'" (Genesis 1: 3 *et passim*). But such a discussion is more proper for theologians. Let us return to the mundane consideration of Near-Man, and to the question of whether or not he had culture.

For a while, it was thought that *australopithecus* possessed a knowledge of fire, an indication of culture. A closer examination of the evidence reveals that this was not the case. Dart (1949) has pointed out that Near-Man did not have long, sharp canines with which to defend himself, nor was his muzzle protruding so much as the ape's in order that he could effectively employ what teeth he had. Consequently, this student has proposed that Near-Man wielded for a weapon a wicked ungulate thigh bone. Oakley (1954) does not object to this idea. Apes have been observed using sticks to reach food, and the woodpecker finch of the Galapagos employs a twig to pry out juicy morsels from their woody retreats. It would have been perfectly permissible for an australopithecine to have employed an extra bone with which to supplement his anatomy, but this would not necessarily indicate he had culture.

Recently, however, primitive pebble tools — made after a definite tool-making tradition — have been found unquestionably associated with australopithecine remains (Robinson, 1956). It is known that man, as we shall discuss in a moment, was living at the same time as the South African fossils, and perhaps he was responsible for these tools. Indeed, some *man* was. A slight bit of negative evidence which seems to bear out this idea is that pebble tools have only been found in one or two out of the five australopithecine sites (Van Riet Lowe, 1957). That Near-Man was incapable of making tools is also the opinion of Oakley (1954). Although the idea that the australopithecines possessed culture is not without advocates, it would appear — although no one can say for sure — that their small brains were not quite up to maintaining a tool-making tradition

handed down from one generation to the next by means of language. It is to be hoped that future evidence will lend support to either one view or the other. For the present we can say that Near-Man was not true man because he had no culture in the generally understood meaning of that word.

Taxonomy, Evolution and Near-Man

Was Near-Man of South Africa an ape-like man or a man-like ape? As we have seen, opinions run the gamut from his being "closely related to the gorilla" (Weidenreich, 1943), or "ground ape(s) of a human cast" (Eiseley, 1956) to being included in the very same genus with man (Mayr, 1950a). "Why not call him an ape and let it go at that?" asks the non-evolutionist. To call him an ape would be perfectly legitimate, but to "let it go at that" would be side-stepping the main issue; viz., what is indicated by similarities between two or more groups of organisms. Here we have a more basic question for our consideration than the one we originally asked. Some Christians believe that each species of animals was specially created. Any similarities between groups must result from a unity in the Divine Plan or from the limitations imposed by the environment of the world of which they were to be a part. Others, with a more intimate knowledge of biology, say that certain changes in groups of organisms do occur within limits, but that the major groups of animals — especially man — are not phylogenetically related. This view has received excellent treatment by Russell Mixter (1953).

The latter is a bold attempt to harmonize evolutionary evidence with traditional ideas of creation. But, while serving to help some Christians in their concern over the harmony of science with faith, is such a view advantageous to the scientist who, paradoxically, has been furnished investigatory incentive by the *whole* evolutionary hypothesis to prove that part of his theory which the Christian finally accepts? The evolutionist forges ahead with his theory to search out other veracities while the Christian is wont to wait until the evidence is in before yielding another inch. Such a position cannot offer a positive, anticipatory approach to scientific investigation, nor is it necessary for a positive Christian testimony.

The evolutionist explains similarities between two groups of organisms as being either caused by adaptation to similar environments (analogy) or sharing some percentage of common genetic material (homology). An example of analogy would be similarities between sea-mammals and fish. An example of homology would be similarities between australopithecines and man. The law of parsimony favors the evolutionary view of homologous similarities indicating genetic relationship. What more logical interpretation could there be when one examines the fossil record? Man did not appear on earth for over 1.5 billion years after living things had been a going concern. Nor did he appear before the first Primates — the Order to

which he belongs. In point of fact, he came on the scene more than 50 million years later. Primates did not exist before Class Mammalia had been established. Mammals, in turn, did not exist before mammal-like reptiles at the close of the Palaeozoic. These did not precede the amphibian-like reptiles swishing their way through fantastic forests of gigantic ferns. About the only familiar face in those days, 250 million years ago, was that of the infamous cockroach. He had found his environmental niche, and was prepared to hang on all the way. The truth of the matter probably is that no other respectable insect wanted it! Evolution says similarities between man and Near-Man result from their having ascended from a common gene pool.

Near-Man and Early Man

Prior to the last decade of the nineteenth century, the only evidence of a precursor to modern human races was the heavy-browed Neanderthal Man. At that time he seemed to fit quite well into the popular concept of the missing link. Although some of his genes may still form part of the present-day human gene pool, he passed out of the picture rather abruptly somewhere around 35,000 B.C. One view (Colbert, 1949) has it that he hybridized with Upper Paleolithic Cro-Magnon Man, the forerunner of modern Europeans. Others (e.g. Howell, 1952) think this is unlikely.

In 1891 a Dutch army surgeon, Dr. Eugene Dubois, went to Java to find the missing link. He reasoned that, since man is hairless, his cultureless ancestor must have lived in a warm place. Whether or not it resulted *ipso facto* from his hypothesis, he found what he was looking for. It turned out to be a scull cap which is quite different from modern forms. Within a radius of 46 feet he also found three teeth, a jaw fragment and a thigh bone, which has recently been tested by the fluorine method and found to be of the same age as the skull. And so, the ape-man who walked erectly assumed his immortal title — *Pithecanthropus erectus.* In 1936, other specimens of the Java Man began coming to light, and within a three year period Dr. von Koenigswald was able to find parts of an infant and three adult crania.

For twenty years, Dr. Otto Schoetensack of the University of Heidelberg visited the nearby Mauer sandpit almost daily in hopes of finding a specimen of early man. In 1907 he joyfully found a human jaw with all of its teeth in place 82 feet below the surface. Among the Mauer faunal remains are a horse, intermediate between the modern and Pliocene forms, and an ancient form of the elephant and rhinoceros. Although the jaw is robust and without chin, the teeth indicate that its owner was human. He must have lived soon after the First Glaciation of the Pleistocene.

We have already referred to Raymond Dart's announcement in 1925 of "an extinct race of apes *intermediate between living anthropoids and man.*" In the same publication he delineated over a dozen humanoid features

of his specimen which he called *Australopithecus africanus.* In China, a relative of Java Man came to light in 1930. Although there is indisputable relationship between the two fossil forms, Peking Man (Pithecanthropus pekinensis) has a larger cranial capacity and is more comfortably human than his Javanese cousin. The skeletal remains (mostly skulls) of some 40 individuals have been exhaustively studied by the late Franz Weidenreich (1943). After 1935 there was an interesting turn of events. An occipital bone and a left parietal, indistinguishable from *Homo sapiens,* were found along the Thames at Swanscombe in a well-documented Second Interglacial deposit. The date, confirmed by geology, associated fauna, and flint implements of a certain type, is comparable to that for most of the Java Man specimens.

In the meantime, a mandible fragment of *Homo sapiens* was discovered in East Africa in a deposit containing remains of a Pliocene "elephant." The Kanam jaw is very ancient and may well be of basal Pleistocene age. (Leakey, 1934). Also, in East Africa a maxilla fragment with two premolars in place was found in 1939. It was given the august title of *Meganthropus africanus* because of its very large size and similarities to *M. palaeojavanicus,* a massive mandible (African specimen is from a *maxilla*) discovered in Java by von Koenigswald in 1941. Just four years ago in Algeria a complete mandible lacking only three incisors and the canines, and a mandibular fragment with premolars and molars *in situ* were found associate with a lithic industry more ancient than that of Swanscombe Man. *Atlanthropus mauritanicus* bears resemblances to Java Man (Arambourg, 1955). This abbreviated list of human fossil forms will suffice our purposes in the ensuing discussion of the relationship of Near-Man to some of them.

At the outset let us make clear the prevailing opinion among evolutionists is that known specimens of the *Australopithecinae* were not ancestral to man. As Simpson (1951) has stated: "Part of the intense current discussion of the relationships of the Australopithecinae seems to a paleontologist rather sterile because it lacks the most essential historical datum, the age of these forms relative to other known fossil hominoids." Now that the dating is more securely fixed, it is known that the australopithecines (extant specimens) were not living before man appeared; therefore, they cannot be ancestral to him. LeGros Clark (1955) clarifies the situation in this manner:

> When it is suggested that *Australopithecus* may be ancestral to later hominids (and on the purely morphological evidence the suggestion is a perfectly valid one), it is not implied that the representatives of this genus found in South Africa are themselves the actual ancestors. The fact is that in their anatomical structure the South African fossils conform so closely to theoretical postulates for an intermediate phase of early hominid evolution (based on indirect evidence) as to lead to the inference that the actual ancestral group could hardly be *generically* distinct.

While LeGros Clark's "theoretical postulates for an intermediate phase" may prove to be correct, they should be tempered by a word from George Gaylord Simpson (1951):

> When a trend has been observed in a given sequence, it seems to be almost irresistible to extrapolate the trend, to assume that it also occurred with about the same direction and rate before the historical segment actually observed. It is by this subjective process that wholly orthogenetic, and wholly imaginary, pictures of phylogeny are built up.

In spite of this precaution, however, that the ancestors of man and the australopithecines could "hardly have been generically distinct" appears certain if systematics has any validity at all. Robinson (1953) points out that Near-Man did not suddenly pop into existence in the early Pleistocene; he must have been around for some time. Besides common evolutionary sense, this is supported by two kinds of evidence. In the first place, australopithecines were living long enough to divide into two genera (Robinson, 1954). The older of these is anatomically closer to man, while the other, somewhat more recent genus (Paranthropus) is characterized by lack of forehead and certain non-human features of the teeth. For a change of this magnitude to have occurred in the gene pool, a good period of time must have elapsed.

Secondly, Robinson (1953, 1955) has noted similarities between both *Meganthropus* specimens and his later genus of *Australopithecinae.* This, if true, would indicate a wide distribution for this form—a time consuming process. Von Koenigswald (1957) who discovered the Java specimen, is not anxious to admit similarities between his *Meganthropus* and Robinson's specimen, but does not object to the two African forms being included together. By the same token, Remane (1954), who has been quite intimate with *Meganthropus africanus,* does not agree that *it* was an Australopithecine! Most differences of opinion revolve around slight dental variations among the various forms. When the dust finally settles, it might well be Robinson who is still on his feet. All of the jaws in question were larger than man's.

A most interesting observation of Robinson (1953a) is that one of the australopithecine specimens (*Telanthropus*) looks like a human jaw which might have belonged to a *Pithecanthropus.* If so, the two forms found in Java would have also occurred in South Africa. This view has been strengthened by the finding of a pithecanthropine specimen in North Africa which Arambourg (1955), in turn, has likened to Robinson's South African "human." Dart (1955) thinks that *Telanthropus* is within the australopithecine range of variation.

The distribution of the *Australopithecinae,* therefore, indicates they had a long history. The earlier, more human-like form had more genes in common with man than the later group. The crucial geological epoch

when *Homo* diverged from an australopithecine-like hominid could have been sometime during the Pliocene. Future investigations may supply us with the answer. For the present, the only known hominid (Heberer, 1955) in the Pliocene is *Oreopithecus.* It will be interesting to learn more about this discovery from an Italian coal mine.

Whatever may be ultimately proved about *Pithecanthropus* in South Africa, the most likely candidate for a transition between *Australopithecus* and *Homo sapiens* is none other than *Pithecanthropus* himself (LeGros Clark, 1955). Near-Man furnishes good evidence that bipedal progression preceded the enlargement of the brain. *Pithecanthropus* possessed a thoroughly human thigh bone which attests his erect posture. But, even though he was human, he had a very small brain, ranging from about 750 cc. or a bit larger to the vicinity of 1000 cc. Not only was the brain small, occupying only 84 percent of the skull length as compared to 92 percent in modern man (Hooton, 1954), but the forehead sharply receded from a bony bar across the top of the orbits. Just posterior to the lateral ends of this supraorbital torus, there was a marked, ape-like constriction. Like Near-Man, the third molar was larger than the second. Four specimens appear to be of middle Pleistocene age, while an infant skull is probably lower Pleistocene. Peking Man (*Pithecanthropus pekinensis*) despite his greater brain capacity (average 1035 cc.) and beginnings of a chin (something that the Java fossil went without) is undoubtedly closely related to *Pithecanthropus erectus.*

It has been suggested that Near-Man's brain-size spans the gap between gorilla and man. Indeed, the upper range must at least closely approach the lower range of *Pithecanthropus.* But we have already cited the example of one well-preserved australopithecine skull with a capacity of 482 cubic centimeters — well within the gorilla range. All things considered, it would be fairly safe to say that Near-Man's *average* brain-size was at least in the upper range of the gorilla. This receives added significance considering the larger relative size of the former, as well as its increased complexity. Greater intelligence might well be indicated for the little South African creature, but no one is sure about it.

Kroeber (1948: 75) has listed the brain and body weights of a number of mammals. A mole's brain weighs only 1.2 grams while the rest of his bulk tips the scales at 40 grams. This gives him a relatively larger brain than man (1.32 kilograms : 62 kilograms), but ordinarily it is evident which is the more intelligent. On second thought perhaps the mole manifests the greater sagacity in his atomic-age-be-prepared precautions! Brain and body proportions are nearly similar for the rhesus monkey, which may be a better comparison since it belongs to the same Order as man.

At the other extreme, a whale's brain is five times as heavy as man's,

but again there is no question as to which is the more intelligent. The whale's body-brain ratio can be as high as 8500 against man's 47, so relative size (together with special development of the cerebral cortex) must have some pertinence. Perhaps a brain-size of less than 800 cc. (pathological in modern man) would not have been abnormal in a fossil group (e.g., *Pithecanthropus*) where the *average* size was at the very lower end of the human range. At the present state of knowledge, we must agree with Mayr (1950a) that "The correlation between brain size and intelligence is very loose." No one can say just how big or complex a brain should be before it is human.

Amid these uncertainties the evolutionist can see this trend. Among animals, man's brain is not only the largest in absolute size (with exception of whales, elephants and porpoises) but, at the same time, the largest relative to body weight (with exception of moles, marmosets and some monkeys). The australopithecine brain was tending toward (in comparison to other large Primates) larger relative and absolute size. This creature existed in basal Pleistocene times and presumably much earlier. *Pithecanthropus,* living at least from early to middle Pleistocene, suggests a continuation of this same trend. Together with these considerations, it should be recalled that the remains at Swanscombe, apparently those of *Homo sapiens,* are also of middle Pleistocene date. This would suggest that, just as *Australopithecus* and *Pithecanthropus* probably enjoyed a long contemporaneity, so did *Pithecanthropus* and the people living at Swanscombe. And if the Kanam mandible definitely belonged to *Homo sapiens* at the base of the Pleistocene, all three forms (*Australopithecus, Pithecanthropus* and *Homo sapiens*) at one time in their lives must have had a look at one another! The simultaneous existence of numerous similar forms, each occupying a slightly different environmental niche, is a common sight as we look in the world around us. It results from the evolutionary process of adaptive radiation. To tack on a final word, it has been pointed out (Broom, *et al.,* 1950) that the Pliocene fossil elephant (Dinotherium), with which the Kanam mandible was generally associated, persisted in Africa until the middle Pleistocene, but anthropologists are inclined to accept an early Pleistocene date for this human fossil.

Having now completed our discussion of Near-Man, I am sure that the overwhelming evidence of his similarities to man has convinced the non-evolutionist reader that, after all, there is proof for man's evolution. But wait! Why did I ever make such an absurd statement? I know as well as you that I have been able to conjure not even a shred of proof during all my diurnal — and nocturnal — diligence in writing the foregoing. Many times I have wanted to take your side of the argument when strength on my side waned. Strangely enough, though, I want to convince no one of

anything. What I really have in mind is to tell you why I prefer the intellectual stimulation provided by the evolutionary approach in my field of anthropology. I shall now tell you why it is complementary to my spiritual understanding.

Evolution and the Christian Weltanschauung

I have always been impressed with the views of one of the Master's stalwarts at eventide in the last century when the fires of debate about evolution were furiously raging in many quarters of Christendom. Professor James Orr (1891), perhaps because he was so well informed on current scientific opinion, could say of organic evolution, "It seems to me extremely probable, and supported by a large body of evidence." The idea of change, both organic and inorganic, dominated Orr's Christian *Weltanschauung.* In refuting the concept of eternal matter, which again is gaining ground in our day, Orr appealed to evolution.

> No doctrine comes here more powerfully to our support than the doctrine of evolution, which some suppose to be a denial of creation. If the universe were a stable system, — i.e. if it were not in a condition of constant development and change, — it might with some plausibility be argued that it had existed from eternity. But our knowledge of the past history of the world shows us that this is not its character; that, on the contrary, it is progressive and developing. Now it lies in the very thought of a developing universe that, as we trace it back through narrower and narrower circles of development, we come at last to a beginning, — to some point from which evolution started.

During the first decade of the present century, no less a Christian intellect than Augustus Hopkins Strong (1907) concurred with Orr.

> Christ is the one and only Revealer of God, in nature, in humanity, in history, in science, in Scripture . . . This view implies a monotheistic and idealistic conception of the world, together with an evolutionary idea as to its origin and progress. But it is the very antidote to pantheism, in that it recognizes evolution as only the method of the transcendant and personal Christ, who fills all and in all, and who makes the universe teleological and moral from its centre to its circumference and from its beginning to now.
>
> Neither evolution nor the higher criticism has any terrors to one who regards them as parts of Christ's creating and educating process. The Christ in whom are hid all the treasures of wisdom and knowledge himself furnishes all the needed safeguards and limitations.

As I have stated elsewhere (Seaford, 1957), an evolutionary view of man's place in nature assists my understanding of the antithesis between flesh and spirit. When I instruct my children in morality I can explain that the human body is an animal closely related to other Higher Primates. An ape's life is characterized by various animal traits: primarily self-centered life, promiscuous sex relations (gibbons are monogamous, but "condone" incest), brutality of anger, hate of enemies. Many men, cloaked in cultural guise, live just like apes. The choice for my children will be between living like apes, with resultant stultification of cultural faculties, or living as only man has the privilege of living — as *man.* To know the total richness of this experience, which in essence is eternal life, one must not only be

"born . . . of the flesh . . . but of God" (John 1: 13).

James Orr (1891: 121-27) believed, "It is indifferent how we interpret the first chapter of Genesis — whether as the result of direct Revelation, or as the expression of certain great religious truths in such forms as the natural knowledge of the age admitted of . . . The main point is the absolute derivation of all things from God . . ."

My rapprochement between Genesis and evolution has not been achieved by a scientific explanation of each Creation Day, but rather I have comprehended the theory of evolution for its tremendous heuristic value, while clinging to the knowledge that "It is he that made us, and not we ourselves" (Psalm 100: 3). Perhaps part of the time I found myself believing in two diametrically opposed views. Physicists have been forced to reconcile themselves to a similar state of mind in explaining light as both waves and particles (Gamow, 1958). Centuries ago the Chinese mind grappled with the same problem of harmony between direct opposites (Bodde, 1953). Events in early Greek philosophy are not without pertinence to the current conflict, in some quarters, between Christianity and evolution. With the zeal of a Darwin explaining variability, Heraclitus taught that almost before a thing is put together it is ready to change into something else. There is no permanence. Countering with anti-evolutionistic ardor, the Eleatics said that nothing changed. One of their number, Parmenides, even went so far as to say that if change were admitted, the impossible situation of something's coming from nothing would also be true. (Note how James Orr, who would have been on Heraclitus' side in this point, employed the same reasoning to disprove eternal matter). The Hegelian synthesis was reached in Empedocles and others. Like a prototypic Gregor Mendel, Empedocles proclaimed that, as the Eleatics taught, there is no change, but Heraclitus was right too! Harmony between the two opposed views is attained by saying that the basic elements (in our case, genes, in vague analogy) do not change (although, some genes, of course, do change). After combining to form one thing they separate (in the form of gametes) to form another, thus the same stuff is used for slightly differing things giving the illusion of change. At least this historic view suggests some parallels with the problem we have discussed.

At times when I encounter that garrulous "hobgoblin of little minds" (a foolish consistency) I find it immeasurably less time-consuming quickly to side-step it in the pursuit of truth. When I cautiously look back over my shoulder a moment later, it is nowhere to be seen — just another hallucination!

Dr. Robert Broom, whose indefatigable efforts are largely responsible for our knowledge of Near-Man, perceived from the fossil bones with which he worked, not only a magnificent evolutionary plan, but One who

did the planning as well (Thrapp, 1950).

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THE CONFLICT BETWEEN SCIENCE AND RELIGION

HEINRICH D. HOLLAND

I

Today the conflict between science and religion, between reason and faith, is regarded by many as finished. Some who hold to this view feel that science has demonstrated its superiority so completely that its pronouncements are always to be preferred to those of religion. Others feel that these two aspects of human life have been shown to be so completely separate that any apparent disagreements between them are either spurious or are due to a misunderstanding of the issues at stake. Another group believes that the pronouncements of a religious text — in our case the Bible — are infallible, and that the discrepancies between this text and science must be due to wrong interpretations of the text, or to errors in the data on which the conclusions of science are based. There is a fourth group, the multitude of people who assume that there is no conflict simply because that is what they have been told; this group does not concern us here.

In opposition to these groups I maintain that for those of us who have grown up in the conservative Christian tradition, the conflict is far from over, and that it is, in fact, one of our continuing important tasks to explore and to map the proper relationship between our science and our religion. To maintain such a position requires an answer to the many who hold that the conflict is dead. What can be said about the view that science has demonstrated its superiority over religion so completely that the fight is over? I think that it is fair to require a definition of the terms 'science' and 'religion' before we proceed further, since much of the argument centers on the meaning of these words. Science I will define as the body of accumulated data on phenomena amenable to precise observation, and the interpretation of these data. Note that this definition makes no distinction between the data of what are usually called the physical and the social sciences. Religion I will define as the body of beliefs on matters of good and evil, on the world of the spirit, and on such other topics as may be contained in religious documents considered authoritative in their revelation of truth.

The crux of the problem clearly lies in the last phrase of the definition of religion. In areas of human knowledge where direct, precise observations can be made, the methodology of the natural sciences is the surest avenue to truth. This methodology, after all, has its basis in the proposition that we can normally trust our senses and our experiences, and that we can arrive at conclusions based on our experiences by means of steps of reasoning which in turn are based on generalizations of our experience. We operate on this principle continually, generally without even being aware of it, and much of science is an extension and refinement of this way of life.

The refinement is, of course, essential in science, and the predictive power of many theories of natural science is strong evidence in favor of the data on which they are based and of the refined methodology used in their formulation. The limitations of the approach are, however, severe. As soon as we try to understand really complex organisms, progress beyond a descriptive stage is painfully difficult, and in matters such as the existence of God this type of approach is essentially ineffective. Matters of good and evil lie expressly outside its province. Thus, the statement that science has proved its superiority to religion so completely that its pronouncements are always to be preferred to those of religion can at best apply only to those matters to which the scientific method can be applied with profit. These include only the "other topics" mentioned in the definition of religion; the overlap between science and religion is therefore limited, and it seems to be quite senseless to reject all of religion on the basis of such reasoning. We cannot live without making value judgments, at the least judgments regarding good and evil; and science cannot give us these values.

But does not this line of reasoning lead directly into the camp of those who feel that the conflict is over because science and religion have been shown to be so completely separate that any apparent disagreements between them are either spurious or due to a misunderstanding of the issues at stake? Perhaps this is so in the case of religions dealing only with doctrines of ethics and theology. I cannot see how it can be true in the case of Christianity. In Christ we believe God entered history in a unique manner. If archeological research could prove beyond reasonable doubt that such a person never lived, or even that he was not crucified under Pontius Pilate, Christianity would be finished. We stand and fall with the authenticity of a historical record. The ethics and theology of the New Testament are central, but they are not self-supporting. It is at least in this sense, therefore, that science and religion are interwoven for the Christian, and it seems to me that it is impossible for us to maintain the essential separateness of these aspects of our lives.

The third point of view is represented among those who feel that the

conflict between science and religion centers on the infallibility of a religious text in its entirety, or with only minor reservations as to possible errors in transmission or interpretation. Among Christians this point of view is characteristic of Fundamentalists, and as an example of it we can cite the statement of faith signed by members of the American Scientific Affiliation. Viewed from the outside, this type of position is attractive. It offers a "package," and it has an appealing simplicity. It also leads to grave difficulties. These are focused probably most clearly in the first two chapters of Genesis. During the past century the battle over these two chapters has raged through tens of thousands of pages. For what is at stake for the Fundamentalist is not only the truth of these chapters, but the logic of his basic premise regarding the Bible as a whole. If Genesis 1 and 2 must be regarded as myth or as inspired folk tales, then the Bible is no longer infallible as a whole; the truth of each section must then be reexamined; the faith is no longer inviolate; the simplicity is a delusion.*

The record of Genesis 1 and 2 is incompatible with the geologic data. Even if the days of Genesis are interpreted as long periods of time, and even if the acts of creation are equated with the slowly changing pattern of living forms on the earth, the sequence of events in Genesis 1 and Genesis 2 cannot be reconciled with the paleontologic record. We are therefore faced with accepting either the paleontologic record, or the validity of the Genesis account, or neither. We will neglect the third alternative and will explore the consequences of the first two. A tremendous amount of observation, collecting, correlating, and dating have gone into the making of the paleontologic record. The rejection of this body of data and of the concept of earth history derived from it would probably require the rejection of the possibility of all historical geologic research and the adoption of a very odd concept of the orderliness of the earth in particular and of the universe as a whole. Thus the Fundamentalist position seems to me to be wrong in this matter, and since the position falls with this case, the whole subject of the biblical record and scientific research is affected thereby. It follows that whenever biblical doctrines of importance hinge on historic fact, science and religion will meet, and, as in the case of Genesis 1 and 2, we must accept the account most thoroughly supported by the available evidence.

In many ways this is a hard doctrine. If we subscribe to it, we admit that our faith may in part be wrongly placed, that we really know only in part, and that we really see through a glass darkly. We must admit that many of the statements we make are really *on faith,* and not derivable

*This and subsequent opinions do not represent the doctrinal position of the *Review.* We do feel, however, that it is important to realize that this is the direction in which some, who still consider themselves theological conservatives, are moving. The issue needs to be brought into the open. See the extensive review of Logan's *In the Beginning God* by Clark for a rebuttal of similar views. — *Ed.*

from an ironclad authority. This position, then, can make the faith of many falter. But the faltering faith and the loss of fervor are not a necessary outcome of this position, if we only remember that the early Christian martyrs had no New Testament at all.

II

The first section of this paper was concerned with defending and establishing a point of view regarding the relationship of science to religion in general, and of modern science and Christianity in particular. It seems profitable to examine this relationship in terms of a particular example; for this purpose I will choose the problem of the time and physical conditions prevailing during the first periods of the existence of life on earth.

The discussion of this problem involves one of the perennial problems of a historical science: the framing of propositions about a time when we were not there personally. In dealing with the history of the last few thousand years we have numerous human records to guide us; but when the question to be answered takes us into the realm of "pre-history," we must rely for our answers on the clues which present-day observations can give us. We are involved in a process of using such observations in constructing a *model* for the history of the earth and of its environment. This model will always be incomplete, and at any one time, the present for instance, it is undoubtedly incomplete and in part wrong. But therein lies the challenge in science, for we believe that the model can be improved, and that we have the tools to do so. We know in part, we see through a glass darkly, we struggle for more insights, knowing full well that a paper written today will probably be outdated in ten years and will almost certainly be obsolete in twenty-five.

The concept of model building is not restricted to the historical sciences. It is a general human activity. Atomic and nuclear physics are concerned with the construction of models which will reproduce the behavior of matter. We reason in these fields from what we can observe to the underlying regularities, and speak of the nuclei of atoms as spherical or as egg-shaped, with a shell structure, or as similar to drops of water. In all of these fields we believe that the model-building process is valuable because we trust the basic assumptions of the process: the validity of our observational data and of our reasoning processes. In theology, model-building is also important. From our experience of God or from data which we believe to be valid revelation we build models of the nature of God, the nature of man, the relationships between God and man, and between men. These models are also incomplete, but they are inherently no less valid than the models of science.

But to return to our problem relating to the origin of life. To obtain information on these matters we look for clues of the past on the earth in

the present. We need not look far. Rocks contain abundant evidence regarding life in the past, and the reconstruction of changes in plant and animal life represents one of the major accomplishments of science since 1800. Only recently, however, have these changes been related to a time scale which can be trusted. Using the radioactive decay of certain naturally occurring atomic nuclei, we have been able to date numerous events in the history of the earth with such precision, that it seems most unlikely that major revisions of our concepts in this area will be necessary. Of course one can never be sure of this. Scientific fact is not equivalent to logical consistency; but there is every indication that the time scale evolved since 1945 is essentially correct. According to this time scale, remains of abundant life are present in rocks of the last 500 million years. Since the earth is at least 3000 million years old, the rocks formed during most of earth history, i.e., during at least 2500 million years, are poor in fossil evidence of either land or marine life. In fact it is only rather recently that really convincing fossil evidence of the presence of life before 500 million years ago has been produced. The exact time of the appearance of life is still unknown, and presumably will remain unknown for some time to come. At present all we can do is look for its traces in ancient rocks. If such evidence is found in rocks of a particular age, we know that life must have started before this, but not how long before. There is a general consensus at present that life existed at least as long ago as 2000 million years. The paucity of fossil evidence between 2000 and 500 million years ago is related to the absence of hard parts in most organisms living in this time interval. How far beyond 2000 million years ago the origin of life took place is uncertain, and, just because of this uncertainty the problem is an exciting aspect of paleontology today.

We can tell a good deal about the surface of the earth about 2000 million years ago. We know, for instance, that sediments deposited then were very much like those being deposited today. The sands of 2000 million years ago are now sandstones, the muds are now mudstones. Evidence for the presence of water in appreciable quantities can be read from minor features of these rocks; among these are ripple marks, slump structures, and graded bedding. Thus the temperature of the earth's surface was between the freezing and boiling point of water, and we can say something about the water vapor pressure in the atmosphere at this time.

Similarly it is possible to derive criteria from the mineralogy of sedimentary rocks as to the amount of oxygen present in the early atmosphere of the earth. Unfortunately the data are still somewhat incomplete, but the information presently available suggests that there was very little free oxygen present in the atmosphere about 2000 million years ago. On the other hand, just as today, carbon was present largely in the form of carbon

dioxide and nitrogen as molecular nitrogen, whereas very much earlier in the earth's history these elements were probably present as methane and ammonia respectively.

This, then, was presumably the general setting for early organisms. Just how life originated is still an open question. Now that experiments on the production of amino acids in electrical discharges through mixtures of water vapor, ammonia and methane, and through mixtures of water vapor, nitrogen and carbon dioxide have shown that these building blocks of proteins can be produced by lightning discharges in the atmosphere, one of the obstacles to the hypothesis of the origin of life by the consecutive build-up of the requisite molecules from non-living matter has been removed. This hypothesis must be regarded as still unproved, and much of the writing on the subject is highly speculative, but it is certainly a most attractive avenue for further research.

The above thumb-nail sketch of thought in this area of earth science should indicate both the accomplishments to date and the limitations of the present state of things. Its relationship to theology is no more obscure than that of everyday events. We speak of prayer and of God's guidance in our lives, and yet describe the world around us in the language of physics. If we can do this, then we can certainly speak of God as having created life, and still propose a mechanism by which living organisms developed from non-living matter by the complicated rules of organic chemistry. The problem is a matter of models, and the difficulties are those of looking hard at the consistency between those models which we hold. I believe that this is the center of the continuing struggle toward clarification of the problem of the relationship between science and our faith.

THE PROBLEM OF MOTION

GORDON H. CLARK

Among those who accept and defend the historic position of Protestantism, interest has recently increased in the philosophy of science. This interest does not arise merely or even mainly from the implications of biological evolution, but rather in part springs from a broader concern with philosophy as a whole and in part from the presence and activity of the scientists among us. The importance of formulating a philosophy of science, whether by Christian thinkers or by secular thinkers, needs no emphasis. What is needed, is, rather, a warning of the difficulties and dangers that attend the attempt. One of these dangers is seen in the frequent neglect of a most basic problem. And the aim of this paper is to bring to the fore the general problem of motion.

The main proposition, the justice of which this paper hopes to support, is that no philosophy of science can be acceptable unless it satisfactorily disposes of the problem of motion. Motion or change is basic to all forms of science. It is the most widespread of all natural phenomena. Physics, chemistry, geology, and the social sciences as well, simply cannot exist without motion. It would seem therefore that a philosophy of science ought to begin with a study of motion.

Although the ancients gave serious thought to this matter, recent philosophy has unfortunately made little progress in explaining motion and modern science has made none at all. On this subject the scientists seem satisfied with a famous statement of Sir Isaac Newton. Near the beginning of his *Principia,* in the Scholium after Definition VIII, he says, "I do not define time, space, place, and motion, as being well known to all." Now, Sir Isaac Newton was a scientific genius of first order, and therefore he is entitled to make a blunder of first order without diminishing his fame. Such a blunder was this assertion, for time, space, and motion are by no means well known to anybody. Recent physics has to some extent seen the need of examining the meaning of time and space; but if any uneasiness about motion has been felt, it is at least safe to say that no explanation has been achieved. The situation today remains about the same as antiquity left it. That situation was a stalemate. The Eleatic arguments against the possibility of motion still oppose the Aristotelian explanation of motion. Since the latter is not too convincing, the Eleatic arguments are dismissed as poor jokes that scientists ought not to bother with. To forget is to solve.

The original joke was Zeno's paradox of Achilles and the tortoise. In that notable race, when Achilles had once allowed his competitor a head start, it slowly dawned on him that he could never overtake the tortoise. Two thousand years have passed since Zeno first told this story, and still no refutation of it commands universal assent. The replies are superficial. One calculates how far Achilles could run in ten or thirty minutes and places him far ahead of the tortoise. Another balances the infinite divisibility of space against the infinite divisibility of time. Aristotle (Physics VIII) addressing himself to the simpler form of the paradox, that of a single body exhausting an infinite series of points as it moves toward a fixed terminus, argued that the moving body does not actually pass through an infinite series of points. Zeno, says Aristotle, treats one point, the midpoint, as two. He takes it as both the end and the beginning of a motion. But this can be so only if the moving body stops at this point and then begins again. If the body is in continuous motion, none of these midpoints is "actualized." The points and the divisions are only potential and do not actually exist. Therefore although it is impossible to pass through or exhaust an infinite number of actual points, there is no difficulty in

passing through an infinite number of potential points.

There is another attempt to answer Zeno. One may protest that since an infinite series does not have a last term, Zeno cannot require the moving body to reach the last term before it starts to move. He cannot erect as a barrier to motion a factor that admittedly does not exist. And yet, did Zeno say that it was necessary to reach the last term? Will not his paradox remain if he simply asserts that motion can not begin so long as there are more terms in the series. And this is long enough.

Well, perhaps a slightly different expedient will allow the body to move. Let us grant that in any finite space an infinite number of points actually exist. Let us also grant that to move from here to there a body must pass through *all* of these points. But let us deny that the body must pass through *each* of these points. That is, we claim, Zeno confused a *collective* all with a *distributive* each. He supposed, mistakenly, that whatever is true of one must be true of the other. Yet there are many examples where the collective all has qualities quite different from the distributive each. Each nail in this keg is easy to pick up; but it is difficult to pick up all of them. Similarly what is true in every case is not necessarily true in general. Aristotle argues that although a theorem be proved for each of the three types of triangle, it has not on that account been proved of triangle generally. Or, finally, each element of a compound may be poisonous (NaCl), but the whole may be good to eat. Zeno therefore was mistaken because he insisted that a moving body must pass every point, when as a matter of fact it need only pass all of them.

Perhaps this last solution is not so suspicious as the previous ones were. But even so, it would only remove an Eleatic objection to motion: it would not furnish a theory, a definition, an explanation of motion. And this last is what is needed. Professional, practicing scientists like Newton may no doubt be excused if they refuse to tell us what motion is; but a philosophy of science cannot decide to bury a problem simply because it has remained so long unsolved. And if motion is basic to all science, one wonders how any natural phenomenon can be explained before this. We cannot, then, dodge the question, What is motion?

In the *Physics,* Book III, Aristotle begins a determined attack on the problem of motion. He spares no effort to arrive at a solution. And effort is required, for the explanation of motion must make use of the concepts of continuity, infinity, place, time, and perhaps void. This is a constant trouble with philosophic subjects. One hardly begins a topic before one discovers that another matter calls for prior attention. We are always being pushed back or forward, until it seems impossible to solve any one problem without solving all. Omniscience is the prerequisite, and omniscience is hard to come by. But Aristotle makes a brave beginning. The

Pre-Socratics had failed to unravel the enigma of motion, chiefly because they did not know what motion is. Their halting hints were faulty as definitions. Within this section (*Physics* III, 1) Aristotle formulates the definition of motion three times. First, he says that motion is the actualization — literally, he says the actuality — of the potential *qua* potential. This cryptic phrase is then explained. When that which is buildable, insofar as it is buildable, is actual, it is being built; and this is the motion or change called building. Note that the completed house is not buildable; it is built, and the motion is completed. Nor is the actuality of brick and wood motion: insofar as the materials as such are concerned, the motion has not yet begun. This motion therefore is the actualization of the buildable *qua* buildable.

Aristotle must insist on the importance of the *insofar as,* the *qua,* the *as such.* Bronze is potentially a statue; but the actuality of bronze *qua* bronze is neither a statue nor motion. To be bronze and to be movable do not mean the same thing. Or, again, to be potentially healthy is not the same as to be potentially sick; for, if it were, to be actually healthy would be to be actually sick. Of course the same person may be sick or well; but the potentialities are different. Motion thus is the actualization of the potential *qua* potential.

The second time Aristotle formulates the definition he says, "Motion is the actuality of a potential being when it operates in actuality not insofar as it is itself, but insofar as it is movable." The third formulation, a few lines below, is essentially a repetition of the first. Now, the second of these three formulations is clearly untenable: it is obviously circular. To define motion as the actuality of the moveable is to use the concept of motion in its own definition. How could one know what *moveable* means, i.e., able to move, unless one first understood motion? This circularity is present also in the example given under the first formulation. What *buildable* means cannot be known until the motions of building are understood. Either then Aristotle has made a circular blunder, or the first and third formulations must somehow escape this criticism. It is not at all certain that the second formulation is a mere slip of the pen which is excusable in the light of the other two. In *Physics* VIII, 1 (251 a 8), a passage presumably referring to *Physics* III 1, Aristotle again defines motion as the actuality of the moveable *qua* moveable. Similarly, a few pages later (257 b 8) he says "Motion is the incomplete actuality of the moveable." It would seem therefore that the taint of circularity is more than merely superficial.

However, Aristotle should be given every opportunity to rebut this charge before a final judgment is entered. Since he furnished two other formulations, these also should be examined. And, it must be admitted,

they contain at least no apparent circularity. Motion is the actualization of the potential *qua* potential. It is requisite, however, to state what is meant by the term potential. In fact, two requirements must be met. First, the term potential must be defined without using the idea of motion, or else the circularity will reappear; and, second, the idea of potentiality must be set forth clearly and unambiguously, or else all physics will remain vague and confused. The clarification of the concept of potentiality is found more in the *Metaphysics* than in these discussions on motion. In Book Delta he says, "Potentiality is a source of motion and change which is in another thing than the thing moved, or in the same thing *qua* other . . . Potentiality then means the source of change or motion . . ." It would seem, however, that this is not altogether satisfactory. In the *Physics* Aristotle defined motion in terms of potentiality, and now in the *Metaphysics* he is defining potentiality in terms of motion. Circularity therefore has not been avoided, and we still do not know what motion is.

There is, however, another passage. In Book Theta of the *Metaphysics* (1048 a 30-b 6) Aristotle defines actuality. "Actuality means the existence of an object, but not in the manner we call potentiality. We say, for instance, that a statue of Hermes is potentially in the block of wood . . . because it can be cut out of it. We also call a man a scholar even when he is not studying, if he is actually capable of studying . . . We must not seek a definition of everything, but be content to grasp an analogy: that as he who is building is to him who can build, and as he who is awake is to him who is asleep, and as he who sees is to him who, though not blind, has his eyes shut . . . so actuality is defined by one member of these antitheses and potentiality by the other." Even in this more extended passage it is a question whether circularity has been avoided. Cutting the statue out of wood, studying, and seeing are motions; and thus potentiality and actuality are explained on the basis of motion. Motion, then, cannot properly be defined in terms of potentiality.

But, says Aristotle, this is not a definition. Potentiality cannot be defined. It must be grasped by analogy. As he who is asleep is to him who is awake, so potentiality is to actuality. Now, the man who is asleep is horizontal and the man who is awake is vertical. Is this what Aristotle means? Of course not. But it is hard to tell what he means, for there are many comparisons that can be made between men asleep and men awake. The former dream, the latter do not. How can one select which point of comparison is intended? It would seem therefore that even if Aristotle has avoided the apparent circularity, he has not given us a clear and unambiguous concept of potentiality.

This argument may now seem to have become all too intricate; but the conclusion should be disturbing enough to jolt one out of any tendency

to doze. The conclusion is not that Aristotle got himself into a jam: such would be merely a piece of historical information. Nor is the conclusion simply the meaninglessness of the concept of potentiality and the uselessness of analogical definitions. Such is of course a valuable warning to any ambitious philosophers who are unknowingly starting up a blind alley. But there is the much more disturbing conclusion that the problem of motion remains unsolved. And in the recesses of our oblivion there still lurks the skeleton of Zeno's Achilles. Perhaps motion is just nonsense.

Newton, as has been said, failed to extricate science from the difficulty because he assumed that the meaning of motion was known to all. On this assumption he proceeded to discuss particular forms of motions. The futility of this procedure is clear enough to philosophers, but perhaps scientists wonder why ancient puzzles should be allowed to hinder modern science. For this reason something, as brief as possible, should be said about two important Newtonian laws: the law of inertia and the law of gravitation. The first of these asserts that a moving body continues indefinitely in a straight line unless subjected to an impressed force; and the second is an attempt to explain the curvilinear motion of the planets.

Now, the best known of all Newton's pronouncements is the one that reveals his failure to explain planetary motion. The law of gravitation expresses with mathematical accuracy the forces necessary to change the rectilinear or inertial motion of a planet into an elliptical path. But when one asks the question, what impresses these forces? Newton replies, *Hypotheses non fingo.* Cajori, Newton's recent editor, has collected some of Newton's letters (*Principia,* Appendix, note 6, pp. 632-635) in which he clearly expresses the limitations of his mathematical law. Gravity, Newton declares, is not a property of bodies; if it were, one body would act on another at a distance, and this is manifestly absurd; indeed, "We are ignorant of the essential properties of matter." Mathematics only measures the quantity of the force; it says nothing about what impresses the force. Newton himself thought it possible that God impresses this force; but this theological opinion is obviously not a part of experimental science. Therefore science has failed to show what forces the planets out of a rectilinear path.

Now, finally, what is the value of the law of inertia? This law states that a moving body continues in a straight path unless compelled to change by an impressed force. The difficulty with this law is well known. To determine a straight line a fixed point is needed. If a hawk in search of a meal flies always toward another bird, and the other bird is darting hither

and yon, the hawk obviously does not fly in a straight line. And if a rocket could be fired so as always to be pointing to the moon, it would not describe a rectilinear path. The determination of a rectilinear path requires a fixed object in absolute space. But there are no fixed objects. The "fixed" stars are not fixed. Hence the law of inertia has no application. It is completely impossible to discover a body moving in a straight line.

Since this paper is but one section of a larger argument, later conclusions are not here sufficiently prepared for; yet it seems that one subsidiary but important point may be made. The problem of motion, particularly the general problem, but also even some special problems remain unsolved. Space, time, and motion are not "well known to all." In this situation a philosophy of science that pretends to justify scientific knowledge of nature is left without any knowledge to justify. Can anything be known about nature if no one knows what space, time, and motion are? Can it even be known that science is supposed to talk about nature?

Wittgenstein, whose unwise assertions approximately equal Newton's wise ones, is surely allowed one very wise remark to match Newton's blunder: "Whereof one cannot speak, thereof one must be silent."

REVIEWS OF BOOKS

In the Beginning, God, by William M. Logan. Richmond: John Knox Press, 1957. $1.50.

Though small this is a significant book. Its thesis is that the first eleven chapters of Genesis are unhistorical. Since the author reiterates this theme a large number of times, only a few of his statements can be quoted. In the Foreword by Elton Trueblood we read, "The stories are not accounts of debatable events which happened too long ago to permit any valid process of verification, but are, instead, accounts of the nature of enduring human problems" (7). The author himself makes these statements: "The writer here was not seeking to write a textbook of history or of science . . . They are parables, not history or explanations . . . There is no attempt to formulate intellectual propositions to state basic truths . . . This is not Adam I am reading about; this is myself" (15-16).

Thus neo-orthodox theologians hope to preserve some moral and religious value for Genesis without having to defend the historical and scientific truth of these chapters. Inasmuch as neo-orthodox hermeneutics is enjoying wide-spread popularity today, it is worth while to examine its thesis with care; and Dr. Logan's book, though small, gives the argument in clearer detail than many another neo-orthodox volume.

Some preliminary clarifications should be made before the quotations above are forgotten. To say that the author (or authors) of Genesis did not intend to write a scientific or historical textbook obscures rather than clarifies the point at issue. It is not claimed that the Bible is a textbook on science or even a textbook on history. The question is not whether Genesis is a textbook; the question is whether the historical statements in the Bible are true or not. To argue that Genesis is not historically trustworthy because it is not a textbook is a logical fallacy. If, now, the author replies, there are no historical statements in Genesis, we shall be happy to examine his reasons for saying so.

Now, this is one of the merits of Dr. Logan's book: he gives his reasons.

> Even a casual reader of the book of Genesis notices a distinct, though unannounced, change of tone at the beginning of chapter twelve. With that chapter begins the story of Abraham and his descendants. From that point on the record has a more concrete sound. It moves more slowly and gives more details. It does not cover a thousand years in a single breath. It slows down to a pace with which we can keep up as it traces the life story of men and a nation.
>
> In contrast, the first eleven chapters of Genesis are epic in their scope. Their sweep is tremendous. Incomprehensible periods of time are covered in a few words. Stupendous events are described with the brevity and matter-of-factness of a child's fairy story (13).

Now, the great Macaulay once wrote *The History of England.* It extends through five volumes of over 500 pages each. But he gets from the Romans to James I in 72 pages. Are we therefore to conclude that these pages are parables and not history? Does it follow that Diocletian and Clovis are simply symbols of myself? The statement "They are parables, not history" is a symptom of the Kierkegaardian disease. This disease is called Either-Or. Its cure is Both-And. Of course Genesis teaches important, extremely important, religious lessons. And in a very real sense, when we read about Adam, we are reading about ourselves. But we are reading about Adam too. Even the author has to admit, "The first impulse is to read it as history, for that, of course, is what it sounds like"! Who then can say that these chapters were not intended to be understood as history?

If, however, the stories are not history, but merely fiction such as the plays of Aeschylus and Shakespeare (15), why should they be taken any more seriously than the works of playwrights or the Babylonian stories of creation? Again, it is to the author's credit that he does not avoid this question.

> The ability to provoke this intense personal response is a mark of divine inspiration and is one of the things that sets the Biblical record apart from similar material we possess from other sources. Marked parallels are found, for example, in the Babylonian and the even older Sumerian stories of creation. A reader who notes only the similarities of detail in the order and processes of creation may conclude that the Genesis account is but another version of an ancient legend common throughout the Middle East. Closer study reveals remarkable difference. The evoking of personal response is utterly lacking in the Babylonian account. The reader remains merely a reader, though perhaps intrigued by the ingenuity of an interesting fable. In the Genesis account the whole world of thought is different. Many details are similar, but the thought is completely inverted. Instead of showing how God can be made to serve the purposes of man, Genesis portrays man as utterly dependent upon and responsible to God. Moreover, instead of numerous gods and goddesses personifying various forces of nature, there stands at the very beginning *one* God who creates matter out of nothing, not just fashioning it out of pre-existent material after the manner of a human craftsman, and who exists independently of all cosmic matter" (16).

Now, this is a fine answer. Moreover I believe it is a true answer. But it is an answer that is inconsistent with the hermeneutic thesis. If the account were merely a fable, if it were not historically true, would anyone reading it for the first time have the intense personal response the author mentions? Perhaps a person who has been brought up to believe the Bible but who has later decided that it is historically inaccurate can preserve his former emotional attachment in some illogical fashion. He can argue that the stories were never intended to be historical, even though they sound like history. By rational argument, however, the rejection of Genesis' historicity can lead only to leveling the stories to those of Shakespeare and to the Babylonian story of creation. In fact, would not the Babylonian myth produce the same intense personal response, if one believed it to be true? Suppose I believed that numerous gods and goddesses actually existed, and that all the Babylonian details were true, would I not be profoundly impressed, and, if rational, adjust my conduct to these facts?

Not only does the author deny that these eleven chapters of Genesis are history; he also denies that they explain anything. He has said, "They are parables, not history or explanations . . . There is no attempt to formulate intellectual propositions to state basic truths" (15). Now, this is very hard to understand. Is not the very first verse an intellectual proposition that teaches the basic truth of creation? Then, too, Gen. 2: 18 (It is not good that the man should be alone) and Gen. 6: 5 (the wickedness of man was great in the earth and every imagination of the thoughts of his heart was only evil continually), even though they have particular references, rather obviously teach basic truths about human nature.

It is, however, in the case of Adam that it becomes most serious to deny the presence of explanation in the account. The author has said, "This is not Adam I am reading about; this is myself" (16). Later on, after a

paragraph on the obvious evils in the world today, the author says of the account of the fall in Genesis III:

> This is not, however, the answer to the philosophical question of where evil comes from . . . This is a vivid portrayal of things as they are [today], not a theory as to how they got that way . . . Moses is not nearer to the Fall than we are because he lived three thousand years before our time. The Fall refers . . . to a dimension of human experience which is always present . . . Everyman is his own Adam . . . Man's tragic apostasy from God is not something which happened once for all a long time ago. It is true in every moment of existence (36, 47-48).

From the mention of Moses to the end, the author is quoting J. S. Whale, but with approval and as explanatory of his own meaning.

Two things should be said about this series of quotations. First, if what they say is true, if Adam is merely a picture of what happens everyday, then it follows that each of us is born perfectly righteous and succumbs to temptation only after marriage. Well, even if the wife can be symbolized away, Adam is portrayed as perfectly righteous. Everyman therefore must meet his first temptation in a condition of perfect righteousness. This view contradicts all pertinent passages in the entire Bible. "Behold I was shapen in iniquity and in sin did my mother conceive me" (Psa. 5: 5). "Who can bring a clean thing out of an unclean? Not one" (Job 14: 4). "That which is born of the flesh is flesh" (Jn. 3: 6). And for this reason these views are utterly out of accord with the standards of the classic Protestant denominations. The Westminster Confession, for example, to which every Presbyterian minister must subscribe, says, "They being the root of all mankind, the guilt of this sin was imputed, and the same death in sin and corrupted nature [was] conveyed to all their posterity, descending from them by ordinary generation" (VI, iii). Thus no one can be a genuine Presbyterian, at any rate, and hold that children are born uncorrupted or that the fall of Adam pictures what happens today.

Quite the contrary, the fall of Adam is both an historical event and an explanation of what happens today. Would it not be somewhat strange that so few children preserve their righteousness if all are born uncorrupted? Is not some explanation needed for the universality of sin? No doubt we can agree with the author that Genesis III is not "the answer to the philosophical question of where evil comes from." But this agreement does not imply that the Fall explains nothing. For one thing it explains why children are born sinners, why some die in infancy, and why all who survive commit voluntary transgressions. These are facts for which neo-orthodox hermeneutics has no explanation.

The ultimate origin of evil is a wider problem. But when a theologian surrenders the explanation of subsidiary points, it is not surprising that he has nothing worthwhile to say on the basic questions. Again referring

to J. S. Whale, the author says, "Man's sinful will cannot be explained: it must remain as the one completely irrational fact in a world which God created" (46). Aside from being incompatible with the third chapter of the above representative Confession, the sentence quoted cannot be made to agree with the sovereignty of God. One of the distinguishing glories of the Reformation is that it faced honestly and answered clearly the question of evil.

There is one advantage in avoiding theological explanations and in regarding the Bible as unhistorical fiction: no longer will apparent discrepancies cause embarrassment or drive the reader to hard study for the purpose of harmonization. Indeed, it becomes possible to enjoy finding a few extra contradictions in the text. Our author, although he belittles the question about Cain's wife, makes quite a point of it. The account is inconsistent, he says, because "Cain's expressed fear that 'everyone that findeth me shall slay me' implies inhabitants of the earth who were not Cain's brethren" (49). This implication is poor logic, for Cain had brothers and sisters. Thus an invalid inference is used to produce a discrepancy where there is none. Likewise, the command that Noah should take in seven of the clean animals conflicts with the fact that the distinction between clean and unclean animals did not originate until much later in Hebrew history (65). But is this a fact? Can the author be sure that there was no such distinction even before Noah's day? The account, like the first pages of Macaulay's history, is very brief, and much has been omitted. Why is not the command to Noah taken as evidence of such a distinction instead of evidence of a discrepancy? The author also asserts that in the account of the flood, one statement makes it last for a year and eleven days, while another verse limits the entire time to sixty-one days (65). Unfortunately the author does not give the second reference.

Now, finally, "What event prompted the Tower of Babel story is of no consequence whatever in comparison with what it teaches" (78). But can it not with equal reason be said, What event prompted the Jesus-story is of no consequence whatever in comparison with what it teaches? If history in Genesis is unimportant, can history be important in the Gospels? If Adam is a myth, is not Christ a myth too? For Adam was the type of him that was to come; and if by one man's offence death reigned by one, much more shall those who receive grace reign in life by one, Jesus Christ; for as by one man's disobedience many were made sinners, so by the obedience of one shall many be made righteous.

On the other hand, if "this is not Adam I am reading about; this is myself," then with equal reason this is not Christ in the Gospels, it is I. And so I am my own Savior. —*Gordon H. Clark*

Man and Time, edited by Joseph Campbell. New York: Pantheon Books Inc., 1957. xx + 414 pp., with index. $5.00.

This volume, sponsored by the Bollingen Foundation, is the third in a series containing lectures chosen from among those delivered annually in the Eranos meetings at Ascona, Switzerland and originally published in Zurich in various Eranos Yearbooks. The spirit of the work may perhaps be expressed best by Max Knoll who states in prefacing his own paper, "In general, a new perspective on the relationship between the various disciplines seems to be opening. An outward sign of this new co-ordination is the fact that all over the world, not only at Ascona at the Eranos meetings, but also in other places, scholars in such diverse fields as theology and biology or psychology and physics are coming together and are beginning once again to unite their special disciplines into a *universitas,* into a new whole. On the inward plane, there must lie back of this phenomenon a new awareness; that is to say, within the individual branches of learning a process of becoming aware of forgotten psychological contents must be taking place, and it is this process and its manifestation with respect to the concept of time which we shall here attempt to describe" (264).

One cannot begin to elaborate on the diverse aspects of this volume, save to say that the psychological moorings appear to be rather largely Jungian. A list of the papers, all but one given in 1951, may best serve to indicate the wealth of reference matter here and the calibre of the contributors. Henry Corbin writes "The Time of Eranos" and "Cyclic Time in Mazdaism and Ismailism;" Erich Neumann, "Art and Time;" Henri-Charles Puech, "Gnosis and Time;" Gilles Quispel, "Time and History in Patristic Christianity;" Louis Massignon, "Time in Islamic Thought;" Mircea Eliade, "Time and Eternity in Indian Thought;" Carl Jung, "On Synchronicity;" Hellmut Wilhelm, "The Concept of Time in the Book of Changes;" Helmuth Plessner, "On the Relation of Time to Death;" Max Knoll, "Transformations of Science in Our Age;" Adolf Portmann, "Time in the Life of the Organism;" and G. van der Leeuw, "Primordial Time and Final Time."

It is obvious that all such symposia volumes will suffer from unevenness of depth or scope, of interest of delivery or of interest on the part of the reader. Many also gain their greatest value in the stimulation of discussion among those present when the papers are read. Possibly the greatest failing in any attempt to publish a notable symposium within reasonable bounds of size and price is to leave this discussion out, as is the case here. An additional difficulty in this work is the historical range of the papers, which more by past insight than by present impact illustrate man's role in time and his ideas about it. Nonetheless, there is still a large measure of pertinence and interest here for anyone acquainted with theology, history, philosophy, comparative religions, psychology, or science in their relation to the mystery

of time. One will agree with Joseph Campbell in his reaction to the papers when he says, "Our minds . . . were prodigiously churned."

—*Thomas H. Leith*

Andrew Connington, by Grace Irwin. Grand Rapids: Wm. B. Eerdmans Pub. Co., 1958. 276 pp. $3.50.

Ordinarily it would be too much to ask in picking up a recent work of Christian fiction to find not only an uncompromising and positive Christian message, but to find it fully clothed in an engrossing story, superb characterization, and the conviction that here is absolute conformity to actual experience. *Andrew Connington* is Miss Irwin's second novel, a sequel to her first, *Least of All Saints,* published in 1952. These two novels have had wide audiences in Canada with both the Christian and secular public. The occasion for this present review is not, therefore, the appearance of a new book, but a novel in its American edition.

Grace Irwin has a special facility with characterization — she can bring equally alive Andrew Connington, pastor of Shorncliffe; the shy, defiant, and pathetic young bride, Joyce Goddard, who dies mysteriously on her honeymoon; the hard and calloused smalltime industrialist, Harris, church leader and unethical opportunist; the saintly old Dr. Murray, whose loss affects us as much as it does Andrew; the young Dr. Dick Williams who sails for Africa as a medical missionary and leaves behind him a self-righteous and stubbornly bitter father; and Andrew's wife Cecily, whose reluctant misunderstanding leaves Andrew to face the wrath of his church leaders in true solitude. Almost from the moment the book begins, the climax is brewing. Everything Andrew does drives him another step toward the inevitable, disastrous clash with his church. Miss Irwin makes it perfectly clear from the earliest chapters that just as Andrew Connington *can not* compromise his growing faith, so his fashionable church can not accept a faith which in any sense would disturb the smooth complacency of their lives.

I suspect strongly that Miss Irwin's familiarity with classical Greek writing has enabled her to by-pass the trivialities of most experience and get to the most basic aspects of the problems of the human spirit. The happiest discovery about this book is that it is not the shoddily melodramatic or superficial kind of plot that too often goes by the title of Christian fiction, but that the writer has brought to the story a mature understanding of spiritual conflict that has lifted the book entirely out of the realm of ordinary Christian fiction. There is in addition a skill in handling scene and dialogue, and a rich and allusive vocabulary.

This is the kind of book that can be given to anyone at all who appreciates good literature. To those of our *Gordon Review* readers who noted particularly Grace Irwin's article, "What is a Christian Novel?" in the Sum-

mer 1958 issue, this novel will come as a fulfillment of expectations. We highly recommend both the article and the two novels.

—Ann D. Ferguson

The Minor Prophets, by Theodore Laetsch. St. Louis: Concordia Publishing House, 1956. xiv and 566 pp. $5.00.

This is one of the finest commentaries on an Old Testament book it has been our pleasure to read in a long time. It is scholarly enough to satisfy the student, and simple enough to edify the average reader. It is evangelical, thoroughly committed to the faith that the Scripture is the inspired Word of God. Although the commentary is primarily exegetical, there are continual devotional expositions and exhortations.

The book as a whole is prefaced by a chapter on "The Historical Background of Literary Prophecy" which sets the scene for the appearance of the individual writers. Most of the prophets have a further introduction dealing with pertinent material as to date, authorship, historicity or particular problems. Each book is carefully outlined and divided into brief sections. Each of these divisions is followed by a short section of grammatical and textual notes which, while not exhaustive, is remarkably complete and shows a very wide acquaintance with the best of modern scholarship and an awareness of every important problem. Following these notes there is a rather full exegesis and exposition of the passage. There is an abundance of cross references to other parts of Scripture. Although no bibliography is given, there are constant references in the text to a very wide selection of authors both in English and German. Not the least of the values of the book is an eighteen-page topical index at the end.

We take pleasure in recommending this reliable, scholarly and spiritual commentary to teachers, ministers, students and Bible lovers as a valuable aid in the understanding of God's Word. *—Philip C. Johnson*

Toward Understanding Jesus, by Elwyn E. Tilden. Englewood Cliffs, N.J.: Prentice Hall, 1956. ix and 289 pp.

Elwyn Tilden is head of the Department of Religion at Lafayette College. This book is written, according to the Preface, "for readers who, having no special interest in ancient history or literature as such, recognize Jesus as one of the great figures in man's religions, and wish to understand him." (p. v) In line with this purpose, there is a preliminary section dealing with Ancient Judaism and the Gospels as written testimonies; then follow two sections on the life and teachings of Jesus and a final section entitled, "Who is He?"

Dr. Tilden seems to assume that his readers will have very little real interest in the subject, other than a faint curiosity concerning Jesus. As a result he writes in such a way as not to frighten them away or to shock

them by bringing them face to face with sinful man's desperate need, and the eternally significant Person, Jesus Christ. Though well and carefully written, the book either avoids or softly mentions such basic and decisive matters as inspiration, the reality of miracles, the truth of the Gospels. Not only the meaning but even the fact of the death and resurrection of Christ are barely mentioned.

The result of this approach is a colorless picture of Jesus that will never repel but will certainly never forcefully attract anyone to Christ. The author says that he is an evangelical Christian, but it would never appear so from this book. The Jesus of whom this book speaks is an interesting but not particularly relevant character out of a dim past. He is not the Son of God, our Lord and Savior Jesus Christ, apart from whom there is no salvation.

—*Philip C. Johnson*

COPIES AND GIFTS NEEDED

The issues of the *Review* for February, 1955 and September and December, 1956 are now out of print. Since those keeping complete files continue to call for them, it would be greatly appreciated if any who can supply these issues would notify us . . . We have also had requests for gift subscriptions for mission-field use. This is an opportunity for some generous person to contribute to a work that is simultaneously missionary and educational.

SURVEY OF SIGNIFICANT ARTICLES

THOMAS H. LEITH

American Association of University Professors Bulletin. Summer. Martin Cronin, "The American Intellectual" and "Science and Humanities in Education" by E. Rabinowitch.

American Scholar has articles on the invasion of privacy, American education and reading habits, and basic elements in the new world crisis in the Autumn issue.

Annals of the American Academy of Political and Social Science. The September issue is on pressure groups and lobbies in government.

Asbury Seminarian, Spring-Summer. Articles on Barth's Christology and Wesley's mysticism.

Atlantic for October has Eugene Youngert, "College Athletics."

Australasian Journal of Philosophy, May. Two articles on "Free Will: Problem or Pseudoproblem."

Bibliotheca Sacra for April and July has K. S. Kantzer, "Revelation and Inspiration in Neo-Orthodox Theology" and E. E. Cairns, "Eschatology and Church History."

British Journal for the Philosophy of Science, August. M. Grene discusses the neo-Darwinian vs. Schindewolf debate on interpreting the fossil record. To be continued. Important.

Canadian Journal of Theology, July. Articles on existentialism and Christian faith and on logical analysis, logical positivism, and metaphysics. Logic and theology is discussed in October.

Catholic Biblical Quarterly. The last issue has two articles on inspiration and innerancy.

Centennial Review, Summer. W. W. Main, "Symbol and Object in Science and Literature."

Christian Century, July 16. A. Nygren, "The Religious Realm of Meaning." On October 1, W. N. Pittenger has a critique of C. S. Lewis. On October 8, Nathan Pusey writes on secularism and religion, and Martin Luther King, Jr.

discusses the church and the race crisis.

Christianity Today for July 21 has "The Challenge to Orthodoxy," for July 7 has articles on alcoholism, for August 18 has Irving Howard, "Christian Approach to Economics," and for September 1 has Gordon Clark, "A Fresh Look at the Hypothesis of Evolution."

Church History, September. J. C. Brauer, "The Rule of the Saints in American Politics."

Concordia Theological Monthly, August and September. D. R. Hillers, "An Historical Survey of O. T. Theology Since 1922."

Confluence has a discussion of prospects for socialist parties and labor movements in the Summer number.

Current History, July to September. These 3 issues study intensively Soviet, French, and British education.

Daedalus, Summer. Tillich writes "The Religious Symbol," Amos Wilder discusses the cross, K. Burke discusses the first 3 chapters of Genesis, Talcot Parsons analyzes American religious organization, and Heisenberg writes, "The Representation of Nature in Contemporary Physics."

Diogenes, No. 22. A. Dupont-Sommer, "Problems Regarding the Dead Sea Scrolls" and M. Chapiro, "Anxiety and Society."

Dublin Review, Spring. A symposium on space travel. The summer issue is largely on Catholicism and higher education.

Etc., Summer. S. Krislov, "Semantics and the Judicial Process."

Eternity, August. H. Hoyt, "What is Spiritual Healing?" and C. P. Wagner begins a discussion of bibliolatry.

Ethics, July. F .A. Hermens, "Ethics, Politics, and Power" and F. A. Hayek, "Freedom, Reason, and Tradition."

Evangelical Quarterly, July-September, H. J. Blair, "Spiritual Healing."

Faith and Thought (formerly Journal of the Victoria Institute), Spring. Articles on religious beliefs in paleolithic man, the fundamentalism controversy, human freedom, and the gift of tongues.

Foreign Affairs, October. Articles on nuclear testing and the problem of peace and on science in our national life.

Frontier, July. J. Lawrence, "The Russian Church and Soviet Society."

Harper's, October. Robt. Oppenheimer, "The Tree of Knowledge."

Harvard Theological Review, July. R. M. Grant, "Studies in the Apologists."

Hibbert Journal, July. Articles on anti-intellectualism and on Old Testament historiography and revelation.

His, October. J. Brodbeck, "A Liberal Education for Conservative Christians" and Paul Jewett, "What's Right About Existentialism?"

Humanist, September-October. Articles on science and humanities in education and on the possibility of an ethical code based on science.

Inquiry. A new journal discussing the contact between philosophy and the social sciences. The first issue had a paper on distinctives of the physical and social sciences and one on the function of moral philosophy. Published at Oslo University it is available from Prof. Crockett, Univ. of Cincinnati.

International Affairs, July. W. D. Clark, "The Asian Revolution."

Interpretation has articles on Buchmanism, the interpretation of Scripture in the ante-Nicene period, and hermeneutics and prophecy in the July issue.

Journal of the American Scientific Affiliation, June. Articles on the formation of living organisms from non-living systems, the cultures of man and the communication of the gospel, some thoughts on a Christian philosophy of science, and on the concept of 'kinds' in Scripture.

Journal of Bible and Religion in April has an article on the Jehovah's Witnesses and in July has Peter Bertocci writing on the goodness of God.

Journal of Biblical Literature in March has 3 articles on hermeneutics and G. E. Wright on archeology and O. T. studies and in September has "Problems of Hermeneutics in Roman Catholic Exegesis" and "Bultmann's History and Eschatology."

Journal of Higher Education, June. Virgil Blum develops a Catholic argument for government subsidies to students in private colleges.

Journal of Philosophy on June 19 has 3 articles on religious knowledge and on

August 14 discusses the meaning of scientific naturalism.

Journal of Religion in April has "Is there 'knowledge' of God?" and "Logicality vs. Alogicality in the Christian Faith."

Journal of Religious Thought. The last issue has J. B. Carey, "Democratic Unionism and Social Change."

Main Currents, May. Edmund Sinnott writes on man's unique distinction.

Modern Age, Summer. Jose Ortega y Gasset, "The Past and Future of Western Thought" and two discussions of minority rights.

Nation for April 12 has an editorial and article on academic freedom, for May 10 has 4 articles on the needs of American public education, for May 24 discusses the Supreme Court and its critics, and for Sept. 13 has two essays on man and the future.

National Geographic, August. A fine picture-article on radiocarbon dating.

National Review, Sept. 13. L. B. Bozell discusses the Supreme Court.

New Republic, May 12. A. M. Bickel, "Judicial Restraint and the Bill of Rights." The August 4 issue is on the independence of the Middle East.

New Scholasticism for July has a long analysis of the Thomistic proof 'ex motu' for the existence of God.

New Testament Studies, April. H. G. Wood, "Present Position of New Testament Theology: Retrospect and Prospect."

Pastoral Psychology, September and October. Articles on divorce and the church.

Personalist, Summer. W. T. Bruner, Jr., who wrote in the last issue of the *Gordon Review,* discusses "Dialectical Personalism and the Problem of Original Sin."

Philosophy and Phenomenological Research, September. R. Demos, "Tillich's Philosophical Theology" and D. Schon, "Ultimate Rules and the Rational Settlement of Ethical Conflicts."

Philosophy of Science, July. Articles on cross-cultural ethical agreement and on ethics and esthetics on a biological basis.

Practical Anthropology, May-June. "The Relationship of Social Structure to the Problem of Evangelism in Latin America" by Eugene Nida.

Reformed Journal for May has an article on education in a period of world crisis and for September has Oppewal discussing the roots of the Calvinistic day-school movement.

Reformed Review, April. J. A., Van der Waal, "The Christian Conception of Work."

Religion in Life for autumn has articles on contemporary trends in Christology. Also Nels Ferré on a definition of God.

Religious Education, July-August. An issue on labor management and religion.

Review and Expositor for April has K. Holl, "The History of the Word 'Vocation'."

Review of Religion in March contains C. J. Ducasse, "Christianity, Rationality, and Faith" and R. S. Westfall, "Isaac Newton: Religious Rationalist or Mystic?"

Saturday Review for Apr. 19 has E. A. Mowrer discussing freedom in the universe of modern science and for Sept. 13 an issue on frontiers of learning in American education.

Science, August 8. Article on the role and status of anthropological theories. On October 10 an article deals with why able students often do not attend college.

Scientific American, July. J. D. Clark, "Early Man in Africa." The entire September issue is on the creative process. From this important series articles on the encouragement of science, the interpretation of life and the physical sciences, and the psychology of imagination stand out.

Theology Today, April. A symposium on Tillich's theology.

Thomist for July contains an article on freedom, responsibility and desire in Kantian ethics.

Times Literary Supplement for August 15 has a large insert of reflections by many well-known names on books in a changing world.

Union Seminary Quarterly Review in May has Tillich discussing Mark 4: 25.

Westminster Theological Journal in May has articles on Christianity and the cultural problem, the interpretation of the early part of Genesis, and the philosophies of history of Tillich and Reinhold Niebuhr.

Torch and Trumpet, July-August. O. T. Allis, "The Time Element in Genesis 1 and 2.

University of Toronto Varsity Graduate. The latest issue has articles describing Chinese and Russian higher education.

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